Department for Energy Security & Net Zero

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ELECTRICITY | GAS | INDUSTRY EXPERTS

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2. Document Control

2.1 REVISION HISTORY

Version	Date	Author	Summary of Change
0.1	19/12/24	Claire Gwyer	Initial review of changes needed
0.2	10/02/25	Chris Cook	Updated report anonymising test participants
0.3	12/03/25	Claire Gwyer	Internal Review
0.4	05/06/25	Chris Cook	Department for Energy Security and Net Zero Review

2.2 APPROVALS

Version	Date	Name	Position / Role
2.0	14/07/25	Matt Johnson	CEO (Engage)

3. Disclaimer

Whilst care has been taken in the collection and provision of this information, Engage Consulting shall not be liable for any errors, omissions, misstatements or mistakes in any information or damages resulting from the use of this information or action taken in reliance on it.

4. Executive Summary

This report is one of the final deliverables from the IDSR-S4_Lot 1 Project (Lot 1). This lot, laboratory testing and demonstration was awarded to a consortium led by Engage Consulting Limited with partners SMS and NMi Certain B.V. and funded by the Department for Energy Security and Net Zero (the Department) and was part of the Interoperable Demand Side Response (IDSR) Programme, a sub programme of the Flexibility Innovation Programme within the Net Zero Innovation Portfolio (NZIP).

It is assumed the reader of this document has a moderate understanding of the IDSR Programme and its objectives. Briefly, some definitions are given here.

Energy Smart Appliance (ESA) - appliance that meets the requirements specified in Publicly Available Specification (PAS) 1878; it is communications-enabled and able to respond automatically to price and/or other signals by shifting or modulating its electricity consumption and/or production

Demand Side Response (DSR) - shifting (in time) and/or modulation (increase or decrease) of electricity consumption and/or production through the controlled operation of ESAs, in line with consumer preferences, in response to signals from, and acting in agreement with, regulated electricity market participants

Demand Side Response Service Provider (DSRSP) - organization using ESAs to provide demand side-related energy management services to regulated electricity market participants

Customer Energy Manager (CEM) - logical entity providing functionality used to manage one or more ESAs, specific to a supply point, in order to provide DSR services

Interface A - The DSRSP and the CEM shall exchange information relating to device registration, de-registration, flexibility offers, DSR events, status and cyber-security breaches across Interface A. Any DSRSP shall be able to communicate with any registered CEM, and vice versa, using Interface A

OpenADR – Interface A must support the use of OpenADR 2.0b. OpenADR 2.0b was published as an IEC International Standard, IEC 62746-10-1:2018 in 2018 by IEC TC57 “Power systems management and associated information exchange”

Interoperability - ability of an ESA to work seamlessly across any appropriate DSR service operated by any authorized system player, including allowing a consumer to switch an ESA to a different DSRSP at any time and maintain DSR functionality

Data Privacy - the secure transmission and storing of data on the device or with any controlling party

Grid-stability - the prevention of outages on the grid caused by inappropriate operation of ESAs

Cyber-security - the appropriate protection of ESAs from unauthorized access and the correct use of ESAs by authorized parties only in order to achieve valid DSR events

Stream 1 – Stream 1 projects designed and developed ESAs (including CEMs) and DSRSP platforms to provide DSR in accordance with PAS 1878 and PAS 1879 specifications.

Stream 2 – Stream 2 projects designed and developed ESAs and DSRSP platforms to provide DSR using SAPC and OpenADR functionality via the GB smart metering system (building on Annex D and Annex F in PAS 1878).

The purpose of the document is to present the approach, progress and summary of findings from the Lot 1 testing within Phase 2 of the IDSR Programme. In this executive summary we outline the findings and recommendations outlined in section 9 of this report.

4.1 FINDINGS AGAINST THE IDSR PROGRAMME OBJECTIVES

This section details our findings of assessing and testing the DSR solutions developed against the first edition of the Publicly Available Specification (PAS) 1878 and submitted to Lot 1 for testing against the IDSR Programme objectives.

- ***Interoperability*** *- The ability of an Energy Smart Appliance (ESA) to be operated by any authorised Demand Side Response Service Provider (DSRSP) for DSR services.*

    - The project found that in testing the Demand Side Response (DSR) solutions developed in the programme has proven, in part, that the standardisation of the Interface A between the DSRSP and the CEM can achieve a level of interoperability but not to a level to support the use case of a Consumer switching their ESA to a different DSRSP seamlessly. In conformance testing all six Stream 1 projects managed to complete registration with an independently developed DSRSP test stub. Within interoperability demonstrations, in two sessions (involving 4 projects). It was proven that the Customer Energy Manager (CEM)/ESA & DSRSP components developed from two separate projects can complete registration and in a single session response mode was observed. However, a high degree of hyper care was required to achieve this outcome, the interoperability event was time constrained with less than 50% of the planned tests being executed (see **Error! Reference source not found.**), the findings support the need for more definition of Interface A, specifically the implementation of OpenADR in the 2nd edition of PAS to ensure that any optionality or variability of the OpenADR specification is specified in the PAS 1878 to achieve a higher level of interoperability to support the use case.

- ***Data privacy*** *- The secure transmission and storage of data on the device or with any controlling party.*

    - The findings of the project were that the principle of data privacy was being adhered to regarding the secure storage and transmission of data although it was not necessary to use any personal data in the test environment. However, the PAS 1878 requirements relating to consumers being in control of data and associated consent procedures in the exchange of out of band information were found to be requiring

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further development in the DSR solutions. In PAS 1878, second stage authentication to allow the consumer to have an approval step in the process was deemed out of scope for this programme as it required further definition to support interoperability.

- ***Grid-stability*** *- The prevention and mitigation of negative impacts to the energy system caused by inappropriate operation of ESAs; and*

    - The requirements in PAS 1878 relating to grid stability were partly met in that projects implemented flex offers which enables the theory that a DSRSP can have up to date knowledge of the flexibility available, CEM operation modes were also defined and there was evidence of DSR solutions returning to a safe state during power or communication interruption although this was never observed during an event. However, there was little or no evidence of the implementation of randomised offsets relating to the Intended Operation or visibility of such randomisation information to identify the offset or information to enable the DSRSP to ascertain if randomisation would be required.

- ***Cyber-security*** *- The appropriate protection of an ESA, systems and data from unauthorised access, to reduce the risk of cyber-attack.*

    - Security testing was not undertaken by Lot 1 in this project as this is specialist testing. However, each project submitted a self-declaration of conformance. It was found that in all cases the development projects declared they had only implemented the minimum set of security features as they were in the early stages of development. No projects had undertaken any security testing, and a small number had undertaken a security risk assessment against the requirements. All projects did acknowledge their importance and intension to implement them later in the development cycle. During testing there was evidence of security features implemented to support the secure exchange of information and authentication such as HTTPS, TLS, message signing and access control although it should be noted we found incompatibility issues with some implementations of signature verification.

4.2 FINDINGS AND RECOMMENDATIONS FROM THE TEST PHASE

This section captures the key findings within the Lot 1 project delivery. It outlines from our experience, observations and challenges during delivery of testing, any findings and conclusions related to those, and suggests, where relevant, wider implications for the Departments consideration.

4.2.1 MATURITY OF THE PAS

PAS 1878 was released in 2021 after an industry led process facilitated by BSI concluded. An objective of the IDSR programme was to validate it could be a mechanism to achieve the Flexibility Plan objectives. The PAS 1878 has been described as a good starting point by stakeholders, hence it is known there were likely to be some gaps in the requirements. The programme has gained valuable feedback for the future of PAS, working with the projects, resolving issues as solutions were developed and tested. The functional area that was most challenging for projects development of the solutions was the registration process, normal operating mode 2 Response and the implementation of OpenADR, however, it should be noted that none of the issues would be regarded as insurmountable, but resolution should be sought in the development of the 2nd PAS edition. The main challenges in the design of the testing schemes, and the execution of testing as follows:

- The structure and format of the PAS made breaking down the PAS requirements into a structured, useable format was challenging but it enabled Lot 1 to develop a set of more detailed technical use cases. These were shared with all projects and provided a reference point to support the solution development, a structured, headed requirements specification could improve and compliment the main specification.
- There were significant gaps in Annex F and G outlining the use of OpenADR with the Annex G only providing some examples of XML. The majority of issues experienced in testing was related to the implementation of OpenADR and the XML Scheme Design (XSD). To compound the issue, there is a lack of accessible experienced OpenADR resources in the UK, fortunately, Lot 1 managed to access some limited OpenADR resource and a guidance document was produced which had a positive impact on progress, without it, it may have been more difficult to align on some basic requirements. It is recommended that the implementation of the protocol is more clearly defined in the 2nd edition of the PAS, potentially a specific OpenADR Profile.
- It was evident undertaking issue resolution in testing that it wasn't always clear to Lot 1 or the projects where the reference point was for a requirement. Where Annex F superseded the OpenADR specification 2b or where a query or discussion in the Technical Working Group was the reference point. This resulted in projects having differing interpretations and various differences in the way messages were implemented which is a risk to interoperability. Again, this needs greater clarity in the development of the 2nd edition.
- OpenADR Certification was not a requirement of the programme, but it was stated that projects must be compliant. This statement caused confusion across the programme as there was not a clear definition of compliance. Related to the previous point it was not clear which rules apply in the OpenADR specification as the PAS was only utilising two out of the six services a certified solution would need to accommodate. It became clear that projects with certified stacks found it more difficult to align with PAS requirements as development progressed. There was also confusion regarding if projects need to implement the 'push' transport mechanism which the programme team had to clarify. The 2nd edition of the PAS needs to be clear which elements apply to a PAS compliant OpenADR implementation.

4.2.2 MATURITY OF STREAM 1 DSR SOLUTIONS SUBMITTED FOR TESTING

The maturity of DSR solutions eventually submitted by Stream 1 projects for testing was not necessarily at the expected level of maturity the competition guidance stipulated. Feedback from the projects suggested that the maturity and ambiguity in the PAS was a key contributor in extending their timescales and in turn, the Lot 1 timescales, implementing two separate extensions spanning five months to allow those projects a reasonable opportunity to partake in testing. Our understanding of the expected maturity of solutions was stipulated to be Technology Readiness Levels 4 (TRL 4). We believe the TRL of the software element (meeting the PAS requirements) of most, if not all, of the solutions were proof of concept (TRL 3) rather than an integrated solution (TRL 4) ready to be tested independently. This presented several challenges in preparation and execution of testing:

- In preparation for testing the Feature Implementation Pre-Conformance Statement (FIPCS) process was challenging as the maturity of supporting documentation reflected the maturity of the solutions themselves. It was also clear that projects found the process of declaring which requirements they met in their FIPCS submission difficult. An element of this was due to the complexity of how the requirements were presented but in the main it was due to the projects still being in development. The process de-risked testing in allowing us to understand the maturity of the solution before testing is undertaken so an informed decision could be made as to how to get a solution into testing. It was through this process that it became clear that solutions were at an earlier stage of development. This allowed the Programme to adjust its approach to testing, enabling a reasonable amount of testing and learning to take place in the available timescales.
- From a testing requirements perspective, the principles of what a conformance scheme should be, was challenged. In that a conformance / assurance scheme is very binary in its acceptance and measurement of success. It was necessary to change approach, working with the Department it was clear that a more pragmatic approach was required as it was emerging that being fully compliant may not actually be possible. However, getting projects into testing would enable wider learning and transparency of the actual maturity of DSR solutions.
- As DSR solutions were less mature, accessing and operating the test solutions was challenging, some had command line interfaces and multiple components and applications to learn and understand. This made testing more complex and a disproportionate amount of time trying to understand how to operate equipment to gain the desired outcome of the test. The volume of issues was reasonably high, and testing was very stop start, with issue identification, resolution and bug fixes often taking longer than expected to analyse, identify the root cause, agree fix and implement.
- According to the PAS 1878 requirements the ESA creates flexibility offers based on the consumer preferences and sends them via the CEM (VEN)[1] to the DSRSP (VTN) to analyse and select then the DSRSP (VTN) request the CEM (VEN) to execute those offers, a bottom-up approach. It is our understanding that this approach may be different to how DSR services are offered more generally in today's markets where the DSRSP (VTN) is the actor making the offers for the ESA (VEN) to accept, a top-down approach. Our findings were that the logic of the messaging and process between the ESA, CEM and DSRSP functionality worked but there

[1] Virtual End Node (VEN) and Virtual Top Node (VTN) are used by actors in the OpenADR specification 2.0 to communicate, one actor is designated the VTN and the other actors are VENs.

was not enough end to end empirical testing undertaking to prove this conceptual bottom-up approach can work in reality, from that perspective our findings were inconclusive.

- Whilst testing was slower and at times more frustrating than we planned for, the change in approach to lower the threshold to enter testing allowed Lot 1 and the projects valuable learning opportunities that would not have been possible from a desk-based approach. We witnessed solutions increase in stability as we tested, reported issues for projects to fix on fail, implement improvements and progress through testing.

Future requirements for testing in support of the 2nd edition of PAS should consider facilitating more exploratory testing, interoperability events, enabling fix on fail prior a to more rigid conformance / assurance testing.

The complete findings from the Lot 1 project can be found in section 9.2.4 where the information is presented in a tabular format by theme, for ease of reference.

We would like to extend our thanks to members of Department for Energy Security and Net Zero IDSR Programme and wider team who we have worked with over the last two years for their valuable support and active engagement throughout the duration of this project, as well as our partners SMS and NMI and the Stream 1 & 2 projects that participated in the programme. This programme has enabled many key learnings to be identified which will provide a solid foundation for unlocking domestic flexibility as an effective component of our energy system. It has been a pleasure being part of this programme and we would welcome the opportunity to work alongside the Department in the future in progressing our collective net-zero goal.

4.2.3 FINDINGS FROM THE EVALUATION OF STREAM 2 SOLUTIONS

The two Stream 2 projects were not subject to Lot 1 testing however, an evaluation of their conformance to the GB smart metering specification and PAS 1878 was undertaken. It was found that both projects were engaged in the process of achieving the necessary activity to provide an evidence-based conformance statement of their Standalone Auxiliary Proportional Controller (SAPC) but it was still too early in their development process to complete.

Project A provided a demonstration for utilising the GB smart metering system for DSR purposes. However, there were key points for future consideration for improvement (these were key challenges observed):

- The 2A connectivity route (using the smart metering HAN and WAN[2]) was proven to be operational but not currently feasible to operate with the existing GB smart metering system architecture without some changes to the PAS and DCC that may make DSR operations more achievable.

[2] HAN – Home Area Network, WAN – Wide Area Network

Two key suggested changes could be:

- Using (probably new) larger GBCS messages replacing ECS200 and ECS46a to significantly reduce fragmentation; and
- Pending changes in consideration with the Department, PAS 1878/79 updates for flexibility offer exchanges may simplify the routine and response message flows. The DSRSP should generate profiles (and not the ESA).

- The 2B connectivity route (using a web-socket internet link) may be able to match, or narrow the gap, to the Stream 1 solution's levels of performance if a number of changes were implemented including the suggestions above. Project A additionally noted that allowing the GB smart metering system to become a DSR certification signing authority could significantly improve efficiency, alongside a lighter weight message format and removal of polling.

5. Introduction

This report is one of the final deliverables from this project, the IDSR-S4_Lot 1 Project (Lot 1). This lot, laboratory testing and demonstration was awarded to a consortium led by Engage Consulting Limited with partners SMS and NMi Certain B.V. and funded by the Department for Energy Security and Net Zero (the Department) and was part of the Interoperable Demand Side Response (IDSR) Programme, a sub programme of the Flexibility Innovation Programme with the Net Zero Innovation Portfolio (NZIP).

It is assumed the reader of this document has a moderate understanding of the (IDSR) Programme and its objectives.

The purpose of the document is to present the overall findings from the Lot 1 testing within Phase 2 of the IDSR Programme (see section 0). It provides an overview of the projects involved in the programme (see section 6.1) and an overview of the Lot 1 test approach (see section 6.2). It should be noted that this report has been anonymised to enable the report to be shared more widely, details of the projects involved can be found here.

A summary of the outcome from the testing phase can be found in section 0, which includes an overview of the progress made against the plan and scope (see section 7.1), a summary of the self-assessment submitted prior to test (see section 7.2), a summary of the outcome of Conformance Testing (see section 7.3) and Performance Testing (see section 7.4). Section 8 provides a cross-project assessment of the DSR solution implemented, and section 9 presents the key findings against the objectives and recommendations.

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6. Overview of IDSR Programme, Lot 1 and Projects

The following sub sections provide an overview the IDSR Programme, how this programme fits into the overall Net Zero Innovation Portfolio (NZIP). An overview of the workstreams within the IDSR Programme and the test approach implemented by the Lot 1 project. Overview of IDSR Programme

The Department for Energy Security and Net Zero Flexibility Innovation Programme sits within the overall NZIP and runs to the 31st March 2025. The programme is looking to enable the large-scale electricity system flexibility through smart, flexible, secure and accessible technologies to the consumer market.

The IDSR Programme is a sub programme of the Flexibility Innovation Programme. The IDSR Programme has funded several projects to develop Demand Side Response (DSR) solutions to meet the programme objectives.

The IDSR Programme seeks to test and demonstrate how DSR services can be delivered by two different technical frameworks, according to:

- Publicly Available Specification (PAS) 1878 and the principles of PAS 1879; and
- GB smart metering system in accordance with the Standalone Auxiliary Proportional Controller (SAPC) specification and PAS 1878 Annex D.

These frameworks will be applied as a means to satisfy the 'core principles' set out in the Transitioning to a Net Zero Energy System - Smart Systems and Flexibility Plan 2021. The core principles the programme is looking to achieve are:

- **Interoperability** - The ability of an energy smart appliance (ESA) to be operated by any authorised DSR Service Provider (DSRSP) for DSR services;
- **Data privacy** - The secure transmission and storage of data on the device or with any controlling party;
- **Grid-stability** - The prevention and mitigation of negative impacts to the energy system caused by inappropriate operation of ESAs; and
- **Cyber-security** - The appropriate protection of an ESA, systems and data from unauthorised access, to reduce the risk of cyber-attack.

The following diagram illustrates the IDSR Programme workstreams.

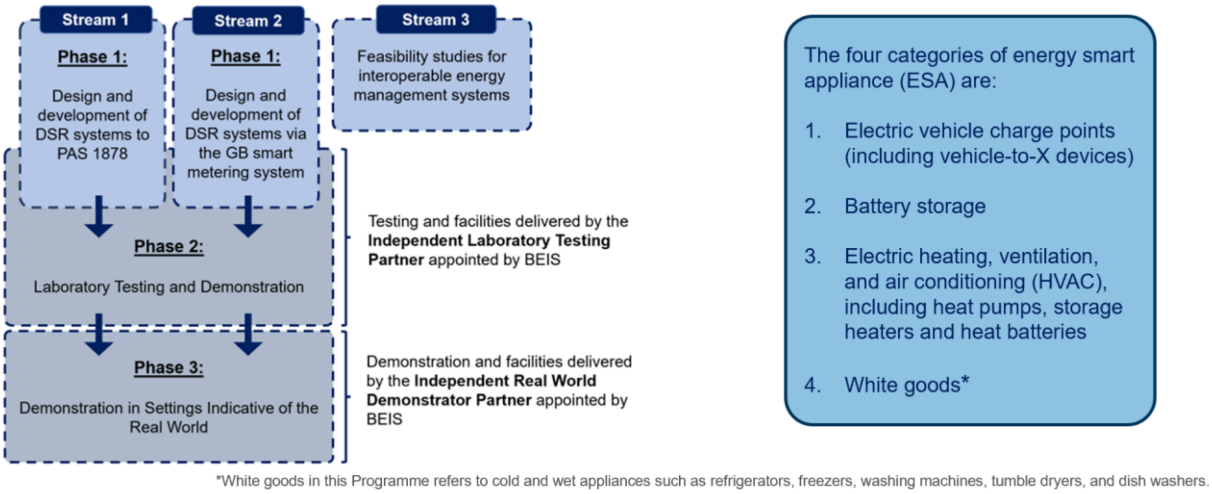

Figure 1 - Overview of IDSR workstream from the Departments information session.

In Phase 1, Stream 1 & 2 projects developed DSR services to PAS 1878 and principles of PAS 1879 (see section 6.1). The Lot 1 project was initiated in September 2022 and in Phase 1, Lot 1 designed and developed a Conformance and Performance Testing Schemes to independently test the Stream 1 & 2 projects DSR solutions and Phase 1 ran through to July 2023.

In Phase 2, Lot 1 implemented the test schemes designed in Phase 1 and initiated testing. The testing activity in Phase 2, ran from July 2023 to the end of August 2024. The Interoperable DSR solutions developed within Phase 1 were assessed and tested to ascertain their level of conformance.

The Final Reporting Suite, which includes this Final Report was developed by the Lot 1 project representing the outcome of the testing phase to be delivered and finalised by the end of October 2024. During August 2024, Lot 1 supported a transition to Phase 3 which is undertaken by a separate consortium known as Lot 2.

In Phase 3, demonstration in settings indicative of real world, undertaking by Lot 2, the DSR solutions are to be moved into the demonstration phase scaling up the testing with a focus on real world scenarios. The testing activity started in September 2024 and is expected to run through to February 2025. The output of Phase 3 will be provided by Lot 2.

6.1 OVERVIEW OF STREAM 1 AND 2 PROJECTS

The development workstreams responsible for developing the DSR solutions are split into two distinct streams of work:

- **Stream 1**: development and demonstration of energy smart appliances to deliver interoperable demand side response according to PAS 1878 and 1879 **(6 projects).**
- **Stream 2**: development and demonstration of energy smart appliances to deliver interoperable demand side response via the GB smart metering system **(2 projects).**

For context, each project is developing a DSR solution, the following diagram outlines the components expected to make up the DSR solution according to the PAS. The three key components set out within the PAS are:

- **DSRSP: D**emand **S**ide **R**esponse **S**ervice **P**rovider.
- **CEM: C**ustomer **E**nergy **M**anager.
- **ESA: E**nergy **S**mart **A**ppliance.

The DSRSP has interfaces to the external markets, communication over Interface A to the CEM. The CEM can reside within the consumer premises or be remote i.e. cloud based. The CEM communicates over Interface B with the ESA which resides in the consumer premises. The CEM and ESA should be provided to the consumer together i.e. every ESA has an associated CEM. Figure 3 illustrates the relationship between the components.

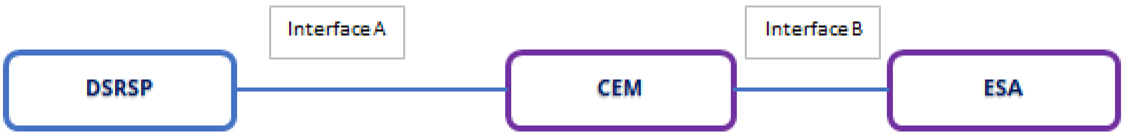

Figure 2 - High Level PAS Architecture

Table 1 details where components have been designed to be located in the premises ⌂ or in a cloud service ☁. For the purposes of aligning to the solution implementations, in this table the Energy Smart Appliance has been split into two elements, the 'Energy Appliance' and the 'Smart Function'. This is due to the projects developing the smart functionality of the ESA separately from the Energy Appliance which in every case was an off the shelf commercial product (see section 8).

Project	Stream	Energy Appliance	Smart Function	CEM	DSRSP
A	1	Battery ES EVSE	⌂	⌂	☁
B	1	Electric Boiler Heat Pump Electric Heater	☁	☁	☁
C	1	EVSE Heat Pump	⌂	⌂	☁
D	1	Heat Pump	☁	☁	☁
E	1	Water Cylinder Electric Heater	☁	☁	☁
F	1	EVSE	☁	☁	☁
G	2	Battery ES EVSE	⌂	⌂	☁
H	2	EVSE	☁	☁	☁

Table 1 - Overview of Stream 1 & 2 Projects

Each project was contracted to develop and test their own DSR solution in preparation for submission to Lot 1 for independent testing.

6.2 OVERVIEW OF LOT 1 TEST APPROACH

The six Stream 1 projects DSR Solutions when developed and tested were to be subject to Lot 1 Conformance and Performance Testing. The two Stream 2 projects were out of scope for Conformance Testing but would be subject to an evaluation of their test approach and conformance with the GB smart metering specifications before entering into Performance Testing.

The Conformance and Performance Testing Schemes designed in Phase 1 were implemented via the IDSR-S4-Lot 1 - Phase 2 Test Plan. Test governance was implemented which included a Testing Steering Group (TSG). The Department took the role of test sponsor on the TSG, its purpose was for Lot 1 to report and escalate issues and to allow the Department to make informed decisions such as a project entering testing.

The Test Plan is made up of two key components:

- The Feature Implementation Pre-Conformance Statement (FIPCS) process.
- The Testing Framework

The following sections describe each of these components in detail.

6.2.1 THE FIPCS PROCESS

The principal objective of the FIPCS process was to provide a mechanism for Stream 1 & 2 projects to communicate detailed technical information to the Lot 1 project test facility for the following purposes:

- Provide detailed knowledge of the domestic DSR equipment to be submitted and its design readiness – this will allow the test facility to fundamentally confirm basic requirements are in place to ensure the equipment type(s) described to be physically tested by the Lot 1 Test Facility in a safe and legal manner;
- Provide a signed off self-declaration from each developer of the status of conformance against relevant PAS requirements; and
- A fully completed FIPCS will provide the necessary information to allow Part 1 desktop evaluation of the submitted equipment to be conducted by the Test Facility under the requirements of the PAS 1878 Testing Schemes.

Iterative engagement with developer projects was a key feature of the process developed to support efficient and timely FIPCS submissions.

Other key features from the outputs of the FIPCS process was to allow the Lot 1 project to:

- Understand in detail each submission, status of development and maturity allowing the test facility to be adapted to the requirements of each developer project;

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- Identify applicable Technical Use Cases (TUCs) and variants for each ESA submitted allowing individual test plans to be confirmed for individual developer projects; and
- Facilitate developer projects to meet the Lot 1 planned start of testing in early November 2023.

The issue management process was used through implementation and execution of the FIPCS process. The process provided the opportunity for learning and understanding, on a case-by-case basis, before laboratory testing commenced.

6.2.2 THE TESTING APPROACH

The foundation of the Test Plan was the Testing Framework which illustrates the structure, scope and approach of testing (see Figure 3).

IDSR-S4 Lot 1 Testing Framework

Phase 2																
		Conformance Testing				Conformance Testing			Performance Testing in Group				Interoperability Demonstration			
		Test Run 1: ESA / CEM				Test Run 2: DSRSP			Test Run 3: ESA / CEM & DSRSP				Test Run 4: Interoperable Groups			
Stream 1 PAS 1878	Project A	ESA(s)	CEM 1	Test Cycles	DSRSP (Stub)	DSRSP Platform 1	Test Cycles	CEM (Stub)	DSRSP Platform 1	CEM 1	ESA(s)	Test Cycles	DSRSP Platform 1	CEM 2	ESA(s)	Test Cycles
	Project B	ESA(s)	CEM 2	Test Cycles	DSRSP (Stub)	DSRSP Platform 2	Test Cycles	CEM (Stub)	DSRSP Platform 2	CEM 2	ESA(s)	Test Cycles	DSRSP Platform 2	CEM 2	ESA(s)	Test Cycles
	Project C	ESA(s)	CEM 3	Test Cycles	DSRSP (Stub)	DSRSP Platform 3	Test Cycles	CEM (Stub)	DSRSP Platform 3	CEM 3	ESA(s)	Test Cycles	DSRSP Platform 3	CEM 4	ESA(s)	Test Cycles
	Project D	ESA(s)	CEM 4	Test Cycles	DSRSP (Stub)	DSRSP Platform 4	Test Cycles	CEM (Stub)	DSRSP Platform 4	CEM 4	ESA(s)	Test Cycles	DSRSP Platform 4	CEM 3	ESA(s)	Test Cycles
	Project E	ESA(s)	CEM 5	Test Cycles	DSRSP (Stub)	DSRSP Platform 5	Test Cycles	CEM (Stub)	DSRSP Platform 5	CEM 5	ESA(s)	Test Cycles	DSRSP Platform 5	CEM 6	ESA(s)	Test Cycles
	Project F	ESA(s)	CEM 6	Test Cycles	DSRSP (Stub)	DSRSP Platform 6	Test Cycles	CEM (Stub)	DSRSP Platform 6	CEM 6	ESA(s)	Test Cycles	DSRSP Platform 6	CEM 5	ESA(s)	Test Cycles
*Stream 2 Projects are Out of Scope of Conformance Testing																
Stream 2 Smart Metering System	Project G	ESA(s)	SAPC Project Review 1						DSRSP Platform 7	CEM 7	ESA(s)	Test Cycles	DSRSP Platform 7	CEM 8	ESA(s)	Test Cycles
SAPC Projects	Project H	ESA(s)	SAPC Project Review 2						DSRSP Platform 8	CEM 8	ESA(s)	Test Cycles	DSRSP Platform 8	CEM 7	ESA(s)	Test Cycles

Figure 3 - IDSR Lot 1 Testing Framework

6.2.2.1 CONFORMANCE TESTING - TEST RUN 1 & 2

The objective of Conformance Testing is to test the individual components of the DSR system against the requirements of PAS 1878. The components of the system to be tested are the DSRSP Platform and the CEM/ESA combination which reside at each end of Interface A. It was not possible to test the CEM and ESA individually as Interface B is not defined in PAS 1878.

The two test runs for Conformance Testing were structured as follows:

- **Test Run 1:** CEM/ESA are under test, to test this component the SMS DSRSP Test Stub was used to emulate the DSRSP connectivity and messaging.
- **Test Run 2:** DSRSP is under test, to test this component the SMS CEM Test Stub was used to emulate the CEM connectivity and the ESA messaging. In addition, validation of the DSRSPs ability to support both OpenADR transports 'Push' and 'Pull' by changing transport at the end

of Test Run 2 to the opposite of transport mechanism implemented into the solutions and undertaking registration test cases.

6.2.2.2 PERFORMANCE TESTING - TEST RUN 3 & 4

The objective of Performance Testing is to validate the operational functionality set out in PAS 1878 work as a complete system when put back together. A complete system in this context is the DSRSP Platform and CEM/ESAs (DSR Solutions) from each project.

The two test runs for Performance Testing were structured as follows:

- **Test Run 3**: DSR Solution is under test, validating the DSR Solution the project has developed (CEM/ESA(s) and DSRSP) is capable of performing a DSR Service.
- **Test Run 4**: Interoperability Demonstration, a replication of the scenario of a consumer switching their ESA to a different DSRSP, validating this is possible by connecting CEM/ESA from Project X to a different DSRSP Platform from Project Y.

Test Run 4 Interoperability groups were subject to the progress of each project completing Conformance Testing, the scope of testing was to focus on registration, further testing was subject to the time available and the stability of the DSR System.

All of the testing was designed to be conducted against the TUCs developed in the scheme design. Test cases and scripts were then developed that mapped to each TUC (see Figure 4).

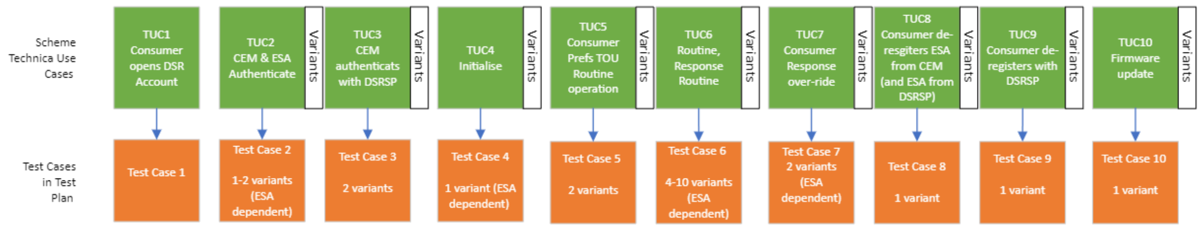

Figure 4 - Technical Use Case Mapping

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7. Outcomes from Lot 1 Testing

This section will be informed by quantitative and qualitative assessment; it will cover respective summaries for the level of conformance submitted; conformance test results; lab performance results; and output from the interoperability demonstration.

7.1 PROGRESS OF LOT 1 TESTING AGAINST PLAN

Lot 1 had a key dependency on the Stream 1 & 2 projects being ready to enter testing within a specific time range within the plan. The potential of delays to the Stream 1 & 2 projects was flagged as a high impacting risk very early in the project. The original plan was for projects to submit their solutions for testing between August and October 2023, unfortunately every Stream 1 & 2 project experienced major delays. The impact of those delays was the compression of the testing window, increasing complexity and parallel activity, increasing the risk of timing out, ultimately presenting a risk to quality. There was also a risk of creating a hiatus through the Summer and Autumn of 2023 which was the original target plan for projects to submit their solutions for testing.

The delays resulted in the Lot 1 project being extended on two separate occasions, once by two months to the end of May 2024 and then an additional three months to the end of August 2024 to increase the chances of each project having a reasonable opportunity of some independent testing.

In the Summer and Autumn of 2023, Lot 1 initiated the FIPCS process. The process itself was expected to be relatively straight forward. However, it was clear the maturity of the solutions and the supporting documentation was not at the expected level. Lot 1 increased its engagement process to work with the projects to support them in their submissions as a pre-testing activity to mitigate the risk of any further delays to testing. Lot 1 also encouraged early installation of testing equipment and commissioning activity to de-risk testing activity further. This approach was reasonably successful as it made areas of non-conformance transparent early. The process allowed Lot 1 to understand the complexity of solutions and the ability to provide an evaluation report to support a decision by the Department to allow projects into testing based on a Lot 1 recommendation.

In parallel with the Stream 1 & 2 projects developing DSR solutions, Lot 1 developed Test Stubs to emulate the DSRSP and the CEM to be utilised within Conformance Testing with Stream 1 projects. Whilst every effort had been made to ensure the Test Stubs were fit for purpose, they had not been used against any third-party solution. The Department also made the decision to make the DSRSP Test Stub available to all projects to support them in their preparation and testing prior to presenting the solutions to Lot 1 testing. The feedback from the projects that were able to access and use the DSRSP Test Stub was that this provided them with an important reference point in their development.

In January 2024, Lot 1 took an opportunity to undertake some pre-testing activity using the Test Stubs with one of the first of the Stream 1 projects ready to submit their solution for testing. This activity was executed through January 2024, it provided both projects with a very valuable learning opportunity whilst all other projects were busy trying to get their solutions ready for testing.

Formal testing started on the 13th February 2024 which marked the formal start of the Lot 1 Conformance Testing.

Stream 2 projects experienced significant delays due to the additional complexity of transferring OpenADR messages over the smart metering system; Lot 1 was able to assess the testing approaches of both projects but were unable to complete the full assessment (see section 7.5). Unfortunately, the impact of the delays was that no Lot 1 Performance Testing would take place. The Lot 1 output for Stream 2 is a part complete assessment of their test approach and compliance with GB smart metering specifications. One of the Stream 2 projects provided a demonstration of their solution in late August 2024 to the Department which was attended by both Lot 1 & 2 testing service providers which signified the end of the work with Stream 2. Our findings from our work with Stream 2 projects can be found in section 7.5.

The experience in testing with most Stream 1 projects was very stop start with high volume of issues, and projects requiring time to apply and test fixes. Lot 1 also applied several fixes to the Test Stubs during the testing window. It was necessary for Lot 1 to apply a very agile approach to testing, allowing less strict management of testing slots to allow projects as much flexibility as possible.

In May 2024 it was starting to become apparent that it may not be possible to complete the full scope of testing set out in the Test Plan. Discussion started with the Department on a proposed approach to prioritise testing activity, mainly proving Interface A and focusing on the main positive test cases and de-prioritising negative test cases. It was also becoming apparent that the smart function of the ESA was a separate component, the significance of this was to challenge the value of testing multiple energy appliances as they were simply a dumb consumption device.

Slow progress continued through the summer and in July 2024 it was necessary to prioritise further by focussing on the Test Runs that had the most value to the programme. Conformance Testing - Test Run 1 & 2 were the priority as they would provide the most value to the projects and de-risk the transition to Lot 2 real world testing. In addition, the decision was made to prioritise a single ESA type where a project had multiple to prove Interface A in the most efficient manner. Performance Testing - Test Run 3 was de-prioritised to allow focus on Test Run 4 - Interoperability Demonstration subject to there being enough time left in the test window. Later in August 2024 a decision was made to timebox Test Run 1 & 2 and leave the last 2 weeks in August to allow projects the opportunity to take part in some interoperability demonstration events.

Despite the delays through the testing window, there were significant benefits from a learning perspective for all the projects and the programme, with sufficient progress to be made to allow exploratory demonstrative testing to continue with Lot 2 scope. There were opportunities to continue to develop the Test Stubs used by Lot 1 and the projects which provided a very useful reference point and some we observed increasing stability within the DSR solutions particularly relating the registration process.

The following sections summarises the findings of FIPCS and the Conformance & Performance Testing and an overview of the desktop evaluation of the Stream 2 demonstration.

7.2 SUMMARY OF SELF-CONFORMANCE SUBMITTED VIA THE FIPCS PROCESS

As stated in section 6.2.1, both Stream 1 & 2 projects completed and submitted a FIPCS as a pre-condition of entering testing. Its purpose is to understand the maturity of the solution before testing is undertaken so an informed decision can be made as to whether a solution is ready. It was through this process that it became clear that solutions were at an earlier stage of development. This allowed the project to adjust its approach to testing, enabling a reasonable amount of testing and learning to take place in the available timescales.

Figure 5 provides an overview of how the 664 requirements[3] normative identified in the PAS 1878 are distributed across the various clauses.

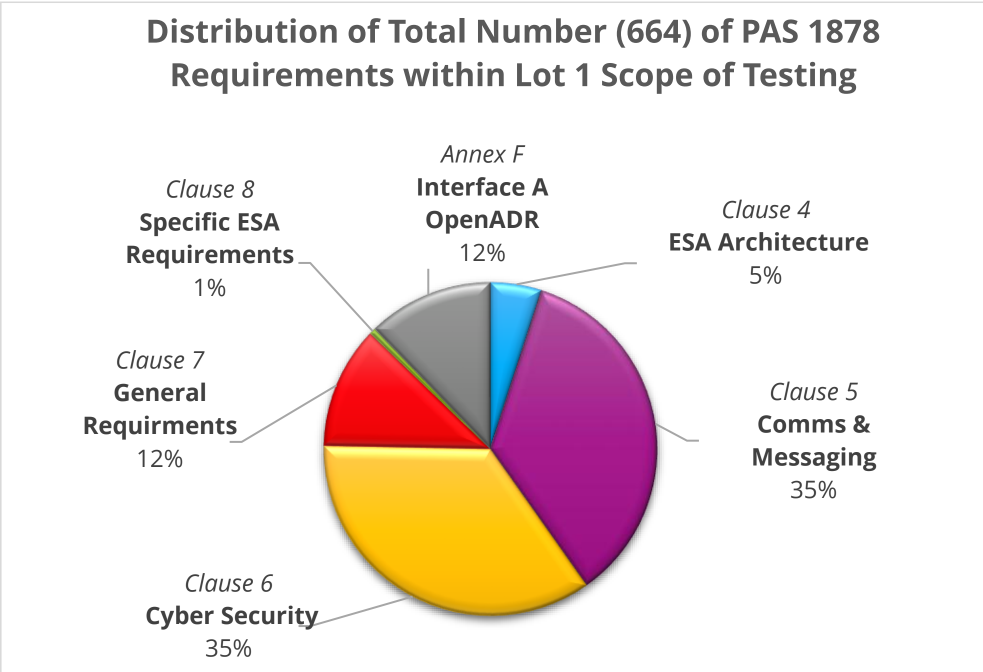

Figure 5 - PAS 1878 Requirements by Clause

Each FIPCS submission was evaluated by the project to assess and confirm the readiness for Lot 1 testing. This analysis also provided an understanding of the maturity of individual projects and related areas of challenge.

Self-reported non-conformance highlighted or identified in the process were logged on a project specific basis as issues. Dialogue with the projects continued through several weeks to understand progress made to resolve the non-conformance. In some cases, this led to multiple submissions before the final position on conformance was understood. There was a total of 438 PAS 1878 requirements where a conformance issue was self-declared for at least one project throughout the process.

[3] Number of requirements within Lot 1's PAS 1878 requirements catalogue (CD01)

Table 2 - FIPCS Evaluation - Overall Conformance

A FIPCS Evaluation Report detailing the findings of each assessment was prepared and provided to the Department for all projects and considered during each relevant decision on whether a project should enter Lot 1 Conformance Testing.

There were several common non-conformance themes and/or challenges that were declared and/or detected during the FIPCS evaluation process. These are set out and described below:

7.2.1 OPENADR COMPLIANCE

- Whilst OpenADR certification was not a requirement for Lot 1 testing, guidance was provided to developers on options available to provide proof of OpenADR compliance using the Lot 1 DSRSP Test Stub or the Quality Logic Test Harness (QLTH) tool used by test houses to provide OpenADR certification.
- A key learning from the project was that PAS 1878 only uses two out of the five services available in the OADR specification 2.0b and the QLTH has test cases to cover all services, the services used by the PAS are;
  - EiRegisterParty Service
  - EiReport Service
- It was proven through the development of the Lot 1 Test Stub that due to the implementation of OpenADR for PAS differing from the implementation of OADR in the QLTH, that only a subset of tests can be run using the QLTH without substantial change.
- However, making some minor amendments with the permission of OpenADR Alliance to the QLTH enables four test cases related to EiRegisterParty Service to be executed. The following changes were made to the QLTH to enable Lot 1 to complete four of the registration test cases:
  - Modification of the registration test;
  - Reporting;
    - Updated XML templates to accommodate custom reports in PAS.
    - Updated JAVA Code for same reason.
    - Some field validations were deactivated to support tests passing as the PAS allowance of values set at 0 creates validation loops as OL tries to divide by zero which crashes the program.
    - OL very specific on power & energy reporting does not look at anything else and will fail anything missing those elements.
  - All messages still comply with OADR XSDs just data values design in PAS that causes issues.

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- The majority of projects that were approved for entry to Lot 1 testing, provided some evidence of OpenADR compliance as part of the FIPCS process. However, it was very minimal, and some projects were not able to provide any evidence within their FIPCS submission, regardless they were progressed for Lot 1 testing on the basis that any issues that arose during testing would be formally logged and managed via the Lot 1 issue management process.

7.2.2 CYBER SECURITY REQUIREMENTS AND RISK ASSESSMENT

- Given the lack of maturity of PAS 1878, the projects within Lot 1 were mainly found to be at an early development stage. Some projects within the scope of Lot 1 were identified as trial builds or suitable for laboratory proving testing only (i.e. not market ready). Due to projects being at the early development stage it emerged that full cyber security testing for the DSR system had not been completed by any developer.

7.2.3 SECURITY LOGS

- Requirements to produce security logs set out in PAS 1878 Clause 6 were mostly not available from projects – this again was a symptom of early-stage development of the DSR system project submissions.

7.2.4 COMMAND LINE USER INTERFACES

- At this early development stage, some projects did not fully meet PAS 1878 requirements in respect of providing a user interface via the CEM and/or ESA. As an alternative, some projects offered parts of the required functionality via a command line user interface tool. Whilst this type of workaround was acceptable for testing purposes, it added complexity and there was a need for additional training to ensure that the tool was accessible and understood by Lot 1 Test Engineers.

7.2.5 CEM/ESA DE-REGISTRATION

As part of responses to specific queries raised through the PAS 1878 queries process, the Department clarified that DSRSP requested de-registration is outside scope of Lot 1 testing and that data retention post de-registration by DSR system components is allowed for testing purposes. It was noted that multiple projects self-reported non-conformance with the requirements relating to de-registration in Clause 5.3.7.

7.2.6 FIRMWARE MANAGEMENT

- Projects with cloud-based ESA and/or CEM components are not able to check for updates as the requirement is stated by PAS 1878 which was specific to a device in a consumer premises checking a manufacturer portal for firmware/software updates before downloading and installing them. Updates for such cloud-based components are provided automatically and not via a specific request via a DSR component. This was not considered to be a barrier to Lot 1 testing. However, firmware management Test Cases were de-prioritised due to the ambiguity and need to focus on the operational requirements. It should be noted that every project had a method of updating software / firmware, but it was not necessarily aligned with the PAS 1878 requirements.

- It was also evident that requirements for software management, generally applicable to cloud-based components, were insufficiently considered within the PAS. It should be noted that there is a risk that equivalent impacts to those applicable to defective firmware management could emerge if software management is not considered (and implemented) as an output of in the 2nd edition of PAS.

7.3 SUMMARY OF THE CONFORMANCE TESTING RESULTS

Stream 1 projects were subject to Conformance Testing. The testing is made up of Test Run 1 & 2 and is focused on and validating the conformance of Interface A. Test Run 1 is the most significant as the CEM and ESA are under test and most requirements of the PAS 1878 are related to these components.

It should be noted that completing Lot 1 Conformance Testing covers 62% of the 664 PAS 1878 identified requirements either explicitly or implicitly. Detailed analysis of conformance levels against the PAS 1878 requirements has not been undertaken as it was not possible to complete testing in the time available and the value of the output was likely to be negligible. However, the percentage of tests completed in the following tables highlights the operational and functional areas that testing covered, which provides a simpler higher-level view of progress achieved.

7.3.1 OVERVIEW OF TEST CASES

As previously stated, all testing was based on ten TUCs from which, test cases and scripts were developed. The following table details the general scope of test cases for Test Run 1. A reduced set of test cases were applicable to all other Test Runs.

The rows of the table highlighted in green are the agreed test cases to prioritise due to the time available, and the test cases highlighted in grey are the test cases that were de-prioritised.

	Process	TUC	Title	Type
	Registration	TC 1	Consumer Registers with DSRSP	Main
		TC 2	ESA & CEM Mutually Authenticate (Fw Not Updated)	Main
		TC 3	ESA and CEM Register with the DSRSP	Main
		3.1	Incorrect Consumer Details	Negative
		3.2	ESA/CEM Already Registered	Negative
		TC 4	Initialization	Main
		4.1	Alternative Power Reporting Type (Selection) (Linked to 6.4)	Optional
Normal Operating Mode	Routine	TC 5	Normal Operation Mode 1 - Routine (ToU & IO)	Main
		5.1	Disable DSR Function (ToU Operation Only)	Sub Case
		5.2	Override IO DSR Function (Change of Mode 1 Operation)	Sub Case
	Response	TC 6	Normal Operation Mode 2 - Routine Response (LD)	Main
		6.1	Select MD Offer	Sub Case
		6.2	Select LD_Power production offer DSR event	Optional
		6.3	Select MD_Power production offer DSR event	Optional
		6.4	Alternative Power Reporting (Report) (Linked to 4.1)	Optional
		6.5	ESA Block FW Update in Response Mode	Optional
		6.6	CEM Block FW Update in Response Mode	Optional
		6.7	Loss & Recovery of Comms	Negative
		6.9	Update Existing LD/MD Flexibility Offer (LD/MD)	Sub Case
		6.10	Select an Additional Flexibility Offer (Not LD/MD)	Optional
	Override	TC 7	Consumer Override Mode 3	Main
		7.3	Reject Flexibility Offer (Consumer Cancels on External Device)	Optional
		7.4	Reject Flexibility Offer (DSRSP Cancels)	Sub Case
	De-registration	TC 8	ESA De-registration from CEM by the Consumer	Main
		TC 9	De-registration from DSRSP by the Consumer	Main
		9.1	CEM De-registration from DSRSP Without ESA Connected	Negative
	Firmware	TC 10	ESA Firmware Updates (Inc Presentation & Rollback)	Main
		10.1	CEM Firmware/Software Updates	Sub Case

Table 3 - Scope of Test Cases for Test Run 1

It should be noted that some test cases were optional depending on whether the solution under test had implemented optional requirements.

Within this section we have presented the key observations and issue themes.

7.3.2 TEST RUN 1 (ESA / CEM)

The component under test in Test Run 1 is the CEM and ESA, the DSRSP is emulated using the SMS DSRSP Test Stub developed by Lot 1.

7.3.2.1 KEY OBSERVATIONS

- Overall, 43% of the planned tests were executed in Conformance Test Run 1 with 35% of test passed and 8% failed, 17% were deemed not applicable and 41% were not run.
- A significant amount of time was spent testing registration and all projects managed to complete registration to a reasonable level.

- Most ESAs had very limited functionality in routine mode, there was little evidence of integration with the energy appliances at this stage.
- Three of the six projects completed a response to a reasonable level from a message exchange perspective. However, the physical response from the energy appliance was more sporadic, in some cases it was very difficult to ascertain if it was the flex offer request the energy appliance had responded to, in some cases the response was still being emulated.
- The response test cases were time critical, and a significant amount of time was spent understanding how to adjust consumer settings to instigate a response to achieve the required test result.
- Despite much less time being spent testing consumer override, three projects executed those tests successfully.
- De-registration had varied results, mainly due to ESA/CEMs being pre-provisioned, most implementations would de-register the DSRSP if the ESA was de-registered from the CEM i.e. it was a single process rather than two separate processes as specified in the PAS 1878.

7.3.2.2 ISSUES THEMES

- Preventable issues in configuration, for example, using Eonti ECC Certificates with SHA256 Fingerprints were identified as issues on several projects during early test cycles. The requirement was communicated through multiple channels from Engage and the Department prior to test entry but we still encountered RSA Certificates installed which caused delays to rectify.
- System stability was a key issue in several projects in Test Run 1. Intermittent connectivity to servers, user interfaces or devices becoming inaccessible or not responding to requests was a frequent problem. With local devices this often meant having to power them down and restart the testing process to re-boot the connection or services, which was time consuming. Cloud based services required the projects to respond to requests to reset their platform or change a configuration to resolve the issue.
- Data management in the projects systems needed improvement. Frequently when the systems were de-registered or re-set for a new testing cycle, residual traces of previous fingerprints remained in databases which caused rejections or mismatches of fingerprints in new test cycles. This was only resolvable through projects executing factory resets through engineer access or manually deleting the fingerprints from the databases.
- Volumes of data generated during tests by constant polling between VEN and VTN and vice versa in terms of logs caused issues in testing. The most common symptom was issues downloading logs for analysis or data capture. It was quickly identified that logs needed to be downloaded no longer than an hour after a system event otherwise it would cause system crashes or freezes due to the data volumes. In one case a project had to return to the lab to upgrade the onboard memory on their CEMs as data volumes were causing stability issues.

- Structure of the XML in the OpenADR messaging was a recurrent issue. There was a lack of consistency in application of values such as DTStart (DurationTimeStart), Duration, Order_ID, DataQuality and VEN_ID. Most of this impacted systems ability to enter routine mode and Intended Operation. Lot 1 acted to clarify this through a dedicated workshop on PAS Query 11 where we suggested a consolidated approach for all projects to align, this was both an interpretation issue of OpenADR optional and mandatory fields and the lack of definition in Annex F.
- Test lab network stability was a recurrent issue through early testing. Assumptions were made based on existing labs operating in the SMS building for smart metering but we still encountered network challenges. We were unable to use the on-site network for testing due to security firewalls and rules around unknown device connection. To overcome this, we procured a SIM based 5G router using the Vodafone network to provide connectivity to the lab. In addition, there were two local sub-networks deployed by projects for their solutions through the same router. Initial testing with one of the solutions using a sub-network had no specific network issues but as soon as we moved to cloud-based solutions, we found that the dynamic IP of our Vodafone router was an issue for connectivity with our cloud based DSRSP Test Stub. We overcame this by procuring a new SIM that had a fixed IP capability and enabled the use of cloud versions of the Test Stubs and projects cloud DSRSPs to operate on the network. There were also issues identified with network contention and capacity with the two local networks connected to the Vodafone router. This manifested in issues locating ports and connecting to devices and the SMS Test stub. A networks expert was brought in and with some rewiring and the addition of another Vodafone router to share the load of the projects the issues were overcome or reduced.
- The readiness of hardware provided by the projects including ESAs and local CEMs (where provided) was a reoccurring issue during test cycles. More than one project did not have any demonstrable connectivity to the energy appliance in the lab at the point of testing as they were still being developed. The project had software that emulated energy appliance responses for the purpose of testing. Another project had a connection to their storage heater but we were also unable to witness any response from their heater when profiles were selected. This was also witnessed on another project where various LD, MD, LD_P and MD_P profiles were attempted but the battery unit failed to respond to any of them due to the energy appliance interface not being developed fully. Where local CEMs were provided there were issues with connectivity dropping and stability of interfaces such as Bluetooth.

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7.3.3 TEST RUN 2 – DSRSP

The component under test in Test Run 2 is the DSRSP, the CEM is emulated using the CEM Test Stub developed by Lot 1.

Within Test Run 2 scope was a specific test cycle to validate the DSRSP ability to support both 'Push' and 'Pull' transport mechanisms. All projects had implemented the 'Pull' transport mechanism, therefore it was planned to switch the DSRSP to use 'Push' and attempt registration. Unfortunately, it was not possible to execute this test cycle in the time available.

7.3.3.1 KEY OBSERVATIONS

- Overall, 25% of the planned tests were executed in Conformance Test Run 2 with 18% of test passed and 7% failed, 18% were deemed not applicable and 57% were not run.
- The majority of time was spent testing registration and three projects managed to complete registration to a reasonable level.
- Projects had resource constraints which hindered issue resolution, the issues encountered in TR2 were never overcome.
- There were issues with fire walls, again resource constraints in the final weeks hindered issue resolution.
- One project hit an issue with signature verification, they were late to start testing TR1 and as a result timed out on TR2.
- Another Project was blocked in TR6 due to a limitation with the Lot 1 CEM Test Stub configuration needed to support the test, unfortunately there was no time to implement a change.

7.3.3.2 ISSUE THEMES

- The SMS CEM Test Stub had less development time and focus than the DSRSP Stub which is more fundamental to the testing. This caused some issues in executing Test Run 2 as its design to execute TUCs was not flexible enough to adapt to the more generic approaches taken by projects to Offer Selection. There were other constraints in the design relating to the Flex_Offer_Forecast and Flex_Offer_Request issues identified in PAS Query 11 related to the design of the XML, the agreed remedy which took a long time to implement. We also identified a design flaw that meant it required an exact match on offer duration time at report level. This initially caused problems in successfully selecting offers.
- XML signatures were an issue for several projects in Test Run 2 with two projects unable to enable them for the entire test run. Investigation suggested this was down to the structure of the signatures in the headers and positioning of the X509 tag.
- Special characters being used in the VEN_ID were a recurring issue in Test Run 2. We observed issues with logs not loading or OpenADR reports not validating or parsing. Root

Cause analysis of the logs identified that the issue was the VEN_ID being prepopulated and inclusion of special characters which were not supported in OpenADR.

7.4 SUMMARY OF THE LABORATORY PERFORMANCE RESULTS

Streams 1 & 2 were intended to be subject to Performance Testing however, due to the Stream 2 project delays, neither of the two Stream 2 projects made it to testing with Lot 1.

The scope of Performance Testing is made up of two test runs, Test Run 3 and 4 using a subset of the Test Cases in Table 3.

Test Run 3 was completely de-prioritised in August 2024 to allow focus on Conformance Test Run 1, 2 and Test Run 4 – Interoperability Demonstration.

7.4.1 TEST RUN 4 - INTEROPERABILITY DEMONSTRATION

Test Run 4 was run as a demonstration event to test interoperability between projects' DSR solutions by undertaking exploratory testing collaboratively. This event was time boxed to two weeks, its success was dependent on projects' willingness to engage in the event and resource being made available. Lot 1 coordinated communication and demonstration sessions. Lot 1 hosted six sessions working with four different projects. The priority was to get through registration to routine mode and time permitting attempt to send a flex offer forecast and flex offer request.

7.4.1.1 KEY OBSERVATIONS

- The interoperability event was constrained to a two-week period with 47% of the planned tests being executed with 31% of tests passed and 17% failed, 53% of the planned tests were not run.
- All projects continued with the ESA used in TR1 & 2.
- The success of the event was dependent on the projects being willing to engage with other projects and making resources available to support live issue resolution, resource constraints and availability hindered progress.
- Despite resource and time constraints we were able to complete a single test scenario of registration and execution of a response.
- In every session, registration was problematic and required hyper care from both participating projects to get through. In most cases making tweaks to parsing and report names but, in some cases, working on hot fix release and then coming back to the event.
- Compared to executing registration, in the one session where response mode successfully executed, the process seemed less problematic, although some live fixes were still necessary to successfully complete a response in the session.

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- The event was well received, projects' feedback was good, and the projects got a lot of value from it despite the event being time constrained. Unfortunately, the events overlapped with Lot 2 preparation which caused some conflicting priorities for the projects taking part.

7.4.1.2 ISSUES THEMES

- There was a lack of consistent approach across projects for pre-registration of out of band information. The immaturity of user interfaces meant that some information such as fingerprints was input through developed interfaces instead. The process as currently defined in PAS 1878 needs to be reformed to be consumer friendly. Manually pre-inputting certificate fingerprints will cause unnecessary failures and retries.
- Initialisation was successful in all sessions with only minor configuration issues encountered when establishing HTTPs and TLS connections. This was a positive theme as creating the connection was a recurrent issue for a number of projects during Test Runs 1 & 2.
- Issues started to be observed when oadrCreatePartyRegistration reports started to be exchanged and were rejected due to multiple XML issues. This included structure of the XML from signature placement, through to report names and use of data points such as VEN_ID. There are clear differences between a solution using a certified stack XSD and the OpenLEADr XSD. The XSD for PAS 1878 needs to be defined with a PAS 1878 OpenADR Profile.
- We observed issues with message response timeouts. Investigation and commentary identified that the cloud side architecture was not production design and relied on services that were not optimised for scale. The result was the maximum timeout period configurable for some projects was 30 seconds (normally more than adequate) which the responding project was struggling to achieve and suggesting 60 seconds.

7.5 SUMMARY OF THE STREAM 2 DEMONSTRATION

Stream 2 projects were responsible for the development and demonstration of energy smart appliances to deliver interoperable demand side response via the GB smart metering system. Unfortunately, due to delays no independent testing was carried out by Lot 1.

However, Lot 1 did support the Department in observing a Stream 2 demonstration. The following observations were captured:

- The demonstration provided useful insight to the benefits and challenges of their design and the solution's use of the existing GB smart metering system for DSR purposes:
    - The key benefits centred on being able to demonstrate that the GB smart metering system can indeed be used for DSR purposes. It is also worth noting that the GB smart metering system infrastructure has been designed with Government's key objectives for the IDSR Programme (interoperability, data privacy, grid stability and cyber security) already in place.

- The key challenges are set out in the points below in this section, especially including key points noted for future consideration for improvement.

- The demonstration was a compromise and not a replacement for the independent testing that was originally intended to be provided through the Lot 1 project.

- The demonstration successfully demonstrated the registration process albeit in a manufacturer's test environment and with acknowledged constraints, e.g. when DCC Boxed was used. The demonstration provided opportunities for utilising the GB smart metering system for DSR purposes. However, there were key points for future consideration for improvement (these were key challenges observed):

  - The 2A connectivity route (using the smart metering HAN and WAN to support DSR services) was proven not currently feasible to operate with the existing GB smart metering system architecture without some changes to the PAS and DCC that may make DSR operations more achievable.

    Two key suggested changes were proposed:

    - Using (probably new) larger GBCS messages replacing ECS200 and ECS46a to significantly reduce fragmentation; and

    - Pending changes in consideration with the Department, PAS 1878/79 updates for flexibility offer exchanges may simplify the routine and response message flows. The DSRSP should generate profiles (and not the ESA).

  - The 2B connectivity route (using a web-socket internet link to support DSR services) may be able to match, or narrow the gap, to the Stream 1 solution's levels of performance if a number of changes were implemented including the suggestions above. it was additionally noted that allowing the GB smart metering system to become a DSR certification signing authority could significantly improve efficiency, alongside a lighter weight message format and removal of polling.

- DCC Boxed was used for its design development and performance testing – this was a reasonable simulation (i.e. it was developed to allow device manufacturers to design and test new products against a DCC emulator). Actual testing within DCC's 'live' test environments should be the formal next step whereby further assurance should be gained, but it was acknowledged that latency may be further impacted when using a 'live' DCC environment.

- In conclusion, it is our opinion that the Stream 2 solutions were taking the right approach in exploring how the GB smart metering system could be used for DSR purposes. Although, we would suggest that another aspect for future consideration could be to use the GB smart metering system for its rich data to help inform DSR operations, instead of focusing the approach on using the GB smart metering system infrastructure to enact DSR operations.

We believe further work will be valuable in order to validate outputs and explore the suggested options to improve efficiency, and to consider changes for incorporation into the next revision of PAS 1878, as well as any wider Department for Energy Security and Net Zero policy angles to help support use of the GB smart metering system data for DSR purposes.

8. Cross Projects Comparison Summary Assessment

As illustrated in section 6.1, each Stream 1 project made choices about their architecture, specifically if the CEM and ESA are located locally or in the cloud. PAS 1878 architecture requirements are weighted towards CEMs and ESAs being located 'in premises', however it allows the concept of a remote CEM.

8.1 ARCHITECTURE ASSESSMENTS

Each project used off the shelf energy appliances (EA); they then developed the smart functionality required by PAS 1878 to operate with the energy appliance for it to be considered an ESA. As the EAs were an off the shelf product the smart functionality developed was logically separate for development purposes creating an additional communication interface to consider, named Int B2 for convenience.

The following diagram illustrates the two broad categories the six Stream 1projects DSR solutions fell into:

- CEM & Smart in Cloud (x4 Solutions)
- CEM & ESA in premises (x2 Solutions)

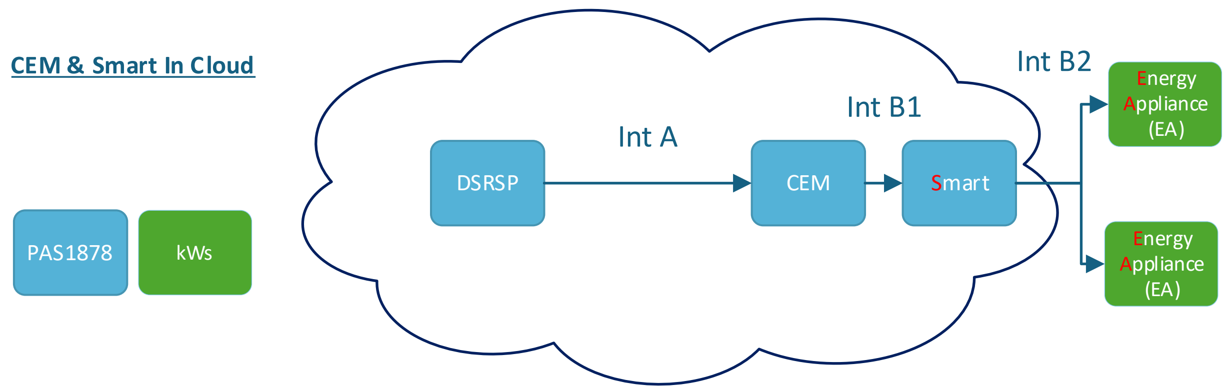

Figure 6 - Diagram of Cloud Architecture

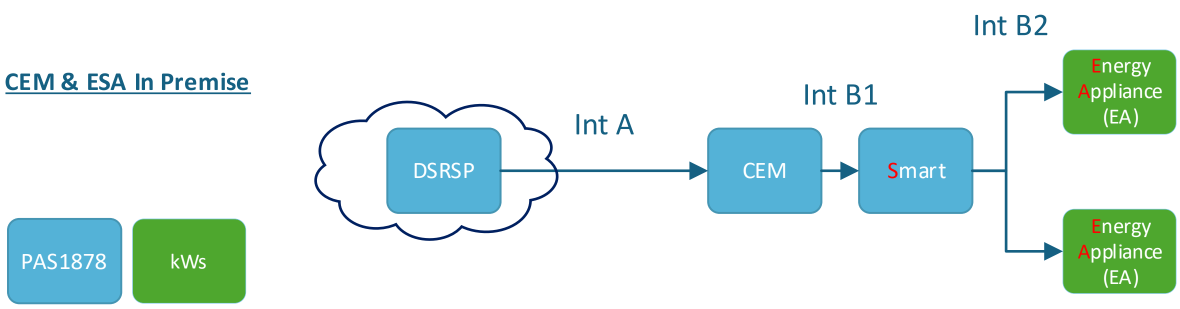

Figure 7 - Diagram of In Premises Architecture

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8.1.1 KEY OBSERVATIONS

- The DSRSP was cloud based in all cases which was expected as per PAS 1879.
- The smart functionality of the ESA in all cases has some logical separation from the EA itself making the energy appliance dumb and simply a consumption device with the exception of battery's which could also store and act as a generation device.
- The solutions with an in-premise architectures were the most aligned to the general PAS architecture.
- The solutions that has cloud based architecture fell into two broad categories:
    - The CEM and smart functionality were in the cloud, but they have kept some logical separation between the CEM and ESA which keeps it aligned to the PAS requirements: and
    - The CEM and smart functionality were in the cloud, but the functionality of both components was found to be merged, which is not aligned to the PAS requirements.
- There were clear advantages of developing in the cloud over the in-premises solutions from a capacity and processing power perspective, we saw more stability and resilience in cloud-based solutions and seemingly less complexity in fixing bugs and releasing new updates compared to in premises solutions that often-required frequent power cycling, firmware updates and memory upgrades. However, it should be noted that all DSR solutions presented for testing were prototype level and clearly stability would be gained later in the development process, and we observed all DSR solutions increase their stability and coverage as issues were resolved.
- In the case of a 'CEM & ESA In Premises' architecture, we would expect the smart functionality shown on the diagram as a separate component to be integrated in production solution. However, in the case of a 'ESA & Smart In Cloud' architecture we believe there are potential risks that could emerge relating to the customer journey and the introduction of a second communication interface which is not recognised in the current version of the PAS.
- The main risk with cloud based CEM is not security, in fact it may be more secure in the cloud as update scan be rapidly deployed and the solution monitored in real time. The risk is that as Interface B is so open in terms of communications protocols permitted, consumers may find their asset 'stranded' and no longer able to use DSR services if their CEM service ceased being provided. Another risk is that if too much functionality is cloud based the ESA may not be able to function or respond to tariff signals without cloud connection. This could be mitigated through enabling either the ESA or another local device, it can connect with, to access tariff from the smart metering system.

8.2 ISSUE STATISTICS

Issues encountered during testing were captured, categorised and severity assessed in an issue tracker at a detailed level, the tracker was then used to manage issues through to resolution. The following provides some basic statistics of issues recorded in the Issue Tracker used by Lot 1.

Status	Count
Total Issues Identified	128
Resolved Issues	110
Open issues	18

Table 4 - Issue Count

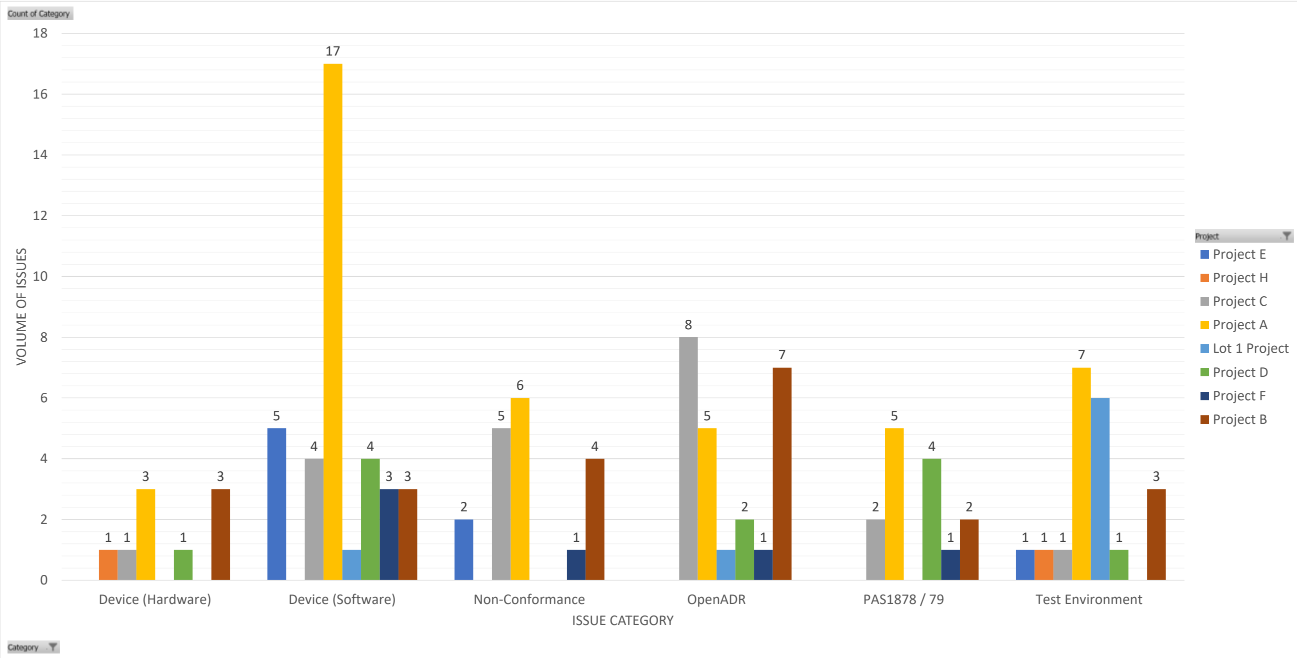

Figure 8 - Issue by Category

Device (Software) category had the highest number of issues allocated to it, the high volume of issues assigned to Project A is representative of the project being the first into testing and the longest time duration.

9. Key Findings and Recommendations

9.1 FINDINGS AGAINST THE IDSR PROGRAMME OBJECTIVES

This section details our findings of assessing and testing the DSR solutions developed against the first edition of PAS 1878 and submitted to Lot 1 for testing against the IDSR Programme objectives.

- ***Interoperability*** - *The ability of an energy smart appliance (ESA) to be operated by any authorised DSR Service Provider (DSRSP) for DSR services.*
    - The project found that in testing the Demand Side Response (DSR) solutions developed in the programme has proven, in part, that the standardisation of the Interface A between the DSRSP and the CEM can achieve a level of interoperability but not to a level to support the use case of a Consumer switching their ESA to a different DSRSP seamlessly. In conformance testing all six Stream 1 projects managed to complete registration with an independently developed DSRSP test stub. Within interoperability demonstrations, in two sessions (involving 4 projects). It was proven that the CEM/ESA & DSRSP components developed from two separate projects can complete registration and in a single session response mode was observed. However, a high degree of hyper care was required to achieve this outcome, the interoperability event was time constrained with less than 50% of the planned tests being executed (see **Error! Reference source not found.**), the findings support the need for more definition of Interface A, specifically the implementation of OpenADR in the 2nd edition of PAS to ensure that any optionality or variability of the OpenADR specification is specified in the PAS 1878 to achieve a higher level of interoperability to support the use case.

- ***Data privacy*** - *The secure transmission and storage of data on the device or with any controlling party.*
    - The findings of the project were that the principle of data privacy was being adhered to regarding the secure storage and transmission of data although it was not necessary to use any personal data in the test environment. However, the PAS 1878 requirements relating to Consumers being in control of data and associated consent procedures in the exchange of out of band information were found to be requiring further development in the DSR solutions. In PAS 1878, second stage authentication to allow the consumer to approve authentication was deemed out of scope for this programme as it required further definition to support interoperability.

- ***Grid-stability*** - *The prevention and mitigation of negative impacts to the energy system caused by inappropriate operation of ESAs.*

- The requirements in PAS 1878 relating to grid stability were partly met in that projects implemented flex offers which enables the theory that a DSRSP can have up to date knowledge of the flexibility available, CEM operation modes were also defined and there was evidence of DSR solutions returning to a safe state during power or communication interruption although this was never observed during an event. However, there was little or no evidence of the implementation of randomised offsets relating to the Indented Operation or visibility of such randomisation information to identify the offset or information to enable the DSRSP to ascertain if randomisation would be required.

- ***Cyber-security*** - *The appropriate protection of an ESA, systems and data from unauthorised access, to reduce the risk of cyber-attack.*

  - Security testing was not undertaken by Lot 1 in this project as this is specialist testing. However, each project submitted a self-declaration of conformance. It was found that in all cases the development projects declared they had only implemented the minimum set of security features as they were in the early stages of development. No projects had undertaken any security testing, and a small number had undertaken a security risk assessment against the requirements. All projects did acknowledge their importance and intension to implement them later in the development cycle. During testing there was evidence of security features implemented to support the secure exchange of information and authentication such as HTTPS, TLS, message signing and access control although it should be noted we found incompatibility issues with some implementations of signature verification.

9.2 FINDINGS AND RECOMMENDATIONS FROM THE TEST PHASE

This section captures the key findings within the Lot 1 project delivery. It outlines from our experience, observations and challenges during delivery of testing, any findings and conclusions related to those, and suggests, where relevant, wider implications for the Departments consideration.

9.2.1 MATURITY OF THE PAS

PAS 1878 was released in 2021 after an industry led process facilitated by BSI concluded. An objective of the IDSR programme was to validate it could be a mechanism to achieve the Flexibility Plan objectives. The PAS 1878 has been described as a good starting point by stakeholders, hence it is known there were likely to be some gaps in the requirements. One of the key objectives of the programme was to validate the PAS as a mechanism for achieving the programme objective, the programme has gained valuable feedback for the future of PAS, working with the projects, resolving issues as solutions were developed and tested. The functional area that was most challenging for projects development of the solutions was the registration process, normal operating mode 2 Response and the implementation of OpenADR however, it should be noted that none of the issues would be regarded as insurmountable, but resolution should be sought in the development of the

2nd PAS edition. The main challenges in the design of the testing schemes, and the execution of testing as follows:

- The structure and format of the PAS made breaking down the PAS requirements into a structured useable format was challenging but it enabled Lot 1 to develop a set of more detailed technical use cases. These were shared with all projects and provided a reference point to support the solution development, a structured, headed requirements specification could provide improve and compliment the main specification.
- There were significant gaps in Annex F outlining the use of OpenADR and Annex G which provided examples of XML. The majority of issues experienced in testing was related to the implementation of OpenADR and the XML Scheme Design (XSD). To compound the issue, there is a lack of accessible experienced OpenADR resources in the UK, fortunately, Lot 1 managed to access some limited OpenADR resource and a guidance document was produced which had a positive impact on progress, without it, it may have been more difficult to align on some basic requirements. It is recommended that the implementation of the protocol is more clearly defined in the 2nd edition of the PAS, potentially a specific OpenADR Profile.
- It was evident undertaking issue resolution in testing that it wasn't always clear to Lot 1 or the projects where the reference point was for a requirement. Where Annex F superseded the OpenADR specification 2b or where a query or discussion in the Technical Working Group was the reference point. This resulted in projects having differing interpretations and various differences in the way messages were implemented which is a risk to interoperability. Again, this needs greater clarity in the development of the 2nd edition.
- OpenADR Certification was not a requirement of the programme, but it was stated that projects must comply with it. This statement caused confusion across the programme as there was not a clear definition of compliance. Related to the previous point it was not clear which rules apply in the OpenADR specification as the PAS was only utilising two out of the six services a certified solution would need to accommodate. It became clear that projects with certified stacks found it more difficult to align with PAS requirements as development progressed. There was also an extended debate regarding if projects should implement the 'push' transport mechanism. The 2nd edition of the PAS needs to be clear which elements apply to a PAS compliant OpenADR implementation.

9.2.2 MATURITY OF STREAM 1 DSR SOLUTIONS SUBMITTED FOR TESTING

The maturity of DSR solutions eventually submitted for testing by Stream 1 projects was not necessarily at the expected level of maturity the competition guidance stipulated. Feedback from the projects suggested that the maturity and ambiguity in the PAS was a key contributor in extending their timescales and in turn, the Lot 1 timescales, implementing two separate extensions spanning five months to allow those projects a reasonable opportunity to partake in testing. Our understanding of the expected maturity of solutions was stipulated to be Technology Readiness Levels 4 (TRL 4). We believe the TRL of the software element (meeting the PAS requirements) of most, if not all, of the solutions were proof of concept (TRL 3) rather than an integrated solution (TRL 4) ready to be tested independently. This presented several challenges in preparation and execution of testing:

- In preparation for testing the FIPCS process was challenging as the maturity of supporting documentation reflected the maturity of the solutions themselves. It was also clear that projects found the process of declaring which requirements they met in their FIPCS submission difficult. An element of this was due to the complexity of how the requirements were presented but in the main it was due to the projects still being in development. The process de-risked testing in allowing us to understand the maturity of the solution before testing is undertaken so an informed decisions could be made as to how to get a solution into testing. It was through this process that it became clear that solutions were at an earlier stage of development. This allowed the Programme to adjust its approach to testing, enabling a reasonable amount of testing and learning to take place in the available timescales.
- From a testing requirements perspective, the principles of what a conformance scheme should be was challenged. In that a conformance / assurance scheme is very binary in its acceptance and measurement of success. It was necessary to change approach, working with the Department it was clear that a more pragmatic approach was required as it was emerging that being fully compliant may not actually be possible. However, getting projects into testing would enable wider learning and transparency of the actual maturity of solution.
- As DSR solutions were less mature, accessing and operating the test solutions was challenging, some had command line interfaces and multiple components and applications to learn and understand. This made testing more complex and a disproportionate amount of time trying to understand how to operate equipment to gain the desired outcome of the test. The volume of issues was reasonably high, and testing was very stop start, with issue identification, resolution and bug fixes often taking longer than expected to analyse, agree and implement.
- According to the PAS 1878 requirements the ESA creates flexibility offers based on the consumer preferences and sends them via the CEM (VEN)[4] to the DSRSP (VTN) to analyse and select then the DSRSP (VTN) request the CEM (VEN) to execute those offers, a bottom-up approach. It is our understanding that this approach may be different to how DSR services are offered more generally in today's markets where the DSRSP (VTN) is the actor making the offers for the ESA (VEN) to accept, a top-down approach. Our findings were that the logic of the messaging and process between the ESA, CEM and DSRSP functionality worked but there was not enough end to end empirical testing undertaking to prove this conceptual bottom-up approach can work in reality, from that perspective our findings were inconclusive.

[4] Virtual End Node (VEN) and Virtual Top Node (VTN) are used by actors in the OpenADR specification 2.0 to communicate, one actor is designated the VTN and the other actors are VENs.

- Whilst testing was slower and at times more frustrating than we planned for, the change in approach to lower the threshold to enter testing allowed Lot 1 and the projects valuable learning opportunities that would not have been possible from a desk-based approach. We witnessed solutions increase in stability as we tested, reported issues for projects to fix on fail, implement improvements and progress through testing.

Future requirements for testing in support of the 2nd edition of PAS should consider facilitating more exploratory testing, interoperability events, enabling fix on fail prior a to more rigid conformance / assurance testing.

9.2.3 FINDINGS FROM THE EVALUATION OF STREAM 2 SOLUTIONS

The two Stream 2 projects were not subject to Lot 1 testing however, an evaluation of their conformance to the GB smart metering specification and PAS 1878 was undertaken. It was found that both projects were engaged in the process of achieving the necessary activity to provide an evidence-based conformance statement of their Standalone Auxiliary Proportional Controller (SAPC) but it was still too early in their development process to complete.

A demonstration was provided for utilising the GB smart metering system for DSR purposes. However, there were key points for future consideration for improvement (these were key challenges observed):

- The 2A connectivity route (using the smart metering HAN and WAN) was proven to be operational but not currently feasible to operate with the existing GB smart metering system architecture without some changes to the PAS and DCC that may make DSR operations more achievable.

  Two key suggested changes could be:

  - Using (probably new) larger GBCS messages replacing ECS200 and ECS46a to significantly reduce fragmentation; and
  - Pending changes in consideration with the Department, PAS 1878/79 updates for flexibility offer exchanges may simplify the routine and response message flows. The DSRSP should generate profiles (and not the ESA).

The 2B connectivity route (using a web-socket internet link) may be able to match, or narrow the gap, to the Stream 1 solution's levels of performance if a number of changes were implemented including the suggestions above. It was additionally noted that allowing the GB smart metering system to become a DSR certification signing authority could significantly improve efficiency, alongside a lighter weight message format and removal of polling.

9.2.4 TABLE OF FINDINGS AND RECOMMENDATIONS

The information is presented in a tabular format by theme, for ease of reference and captures findings that have been highlighted throughout the report as well as some additional specific examples of ambiguous PAS requirements.

ID	Area	Observation / Challenge	Key Finding / Recommendation
L1	**PAS 1878 Requirements**	**Ambiguous Requirements:** At the current stage of PAS 1878 maturity, ambiguities in respect of requirements were identified. Some requirements are unclear and/or not fully defined. This lack of clarity contributed to different participants reaching a range of interpretations of what was required, the list is areas where different interpretations of a requirement was witnessed in the Lot 1 testing.	**A. Registration:** CEM and ESA registration is outlined in PAS 1878 which includes re-tries and the ESA informing the DSRSP (which is not possible). CEM to DSRSP registration does not have re-tries, it is assumed. There is ambiguity in the documented process which needs to be re-defined.
			B. Customer Journey: PAS 1878 does not include complete customer journeys which meant some issues such as, what happens when a registration fails do not exist and could lead to some potential poor customer outcomes.
			C. Consumer Interfaces: PAS 1878 does not specify enough how local consumer interfaces and app / online interfaces integrate and how they should reflect each other.
			D. Flex-Offer-Request Acceptance: When a DSRSP requests an offer from the CEM/ESA and the CEM/ESA accepts the request, PAS 1878 does not require an acceptance/ confirmation message back to the DSRSP. From a process perspective the DSRSP will need to understand if an offer has been accepted before it is executed to be able to understand if it can fulfil its commitments.
			E. Report Names: The naming conventions for the reports were not fully defined in the PAS 1878 and required an additional guidance document.
			F. XML Schema Definition (XSD): PAS 1878 Annex G contains some example XML, but it is not complete nor binding. Future editions of PAS 1878 should contain complete PAS XSD for each report within the OADR messages.
			G. Certificate Authority & Trust model: There were several issues during testing

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			related to certificate type, management and signatures due to incomplete detail in PAS 1878. Future editions of PAS 1878 should include greater clarity on certificates use.
			H. Response Definition: PAS 1878 could be improved with clearer definition of the different types of response and how they co-exist and interact. It is not clear how and if Production, Frequency response and turn up / turn down responses can co-exist and interact with each other. Future PAS 1878 iterations are expected to ensure requirements reflect development in network management services (e.g. frequency response, load management) that are being sought by transmission and distribution system operators.
			I. Randomisation on 0/600 second offsets: PAS 1878 requires the IO to have a randomised offset, not applicable to MD & LD, it also states DSRSP will understand randomised events and decide if randomisation should be applied to an event. We were unable to validate the implementation of randomisation, feedback from projects suggests the requirement was not clear or inconsistent. Requires review and update to PAS 1878, with implications for grid security as GB Smart Metering and may need specialist testing.
			J. ESA implementations with Heat pumps/heating: Further work may be required to provide clearer visibility of the DSR smart functionality to consumers – review once testing completed on current heating projects. Review whether PAS standardisation is required or leave freedom for manufacturers.
			K. ESA UI is working in UTC not local time: All other projects presented used local time for the UI - PAS 1878 does not appear to define a default position with the consumer UIs.
			L. Response Period vs Event Period: Some projects interpreted the point at which the ESA should go into response mode

			was the point at which it received the flex offer request. Others went into response mode at the start of the actual event time. Further clarity of the requirement should be considered in the 2nd edition and the impact it may have on a consumer opportunity to offer multiple events over a longer period (related to H Response Definition).
			M. Certificate Authority: Clause 5.3.3 should define a need for a Certificate Authority and applicable standards that set out which certificates are required and in what header structure (XML signatures). OADR defines acceptable Fingerprint formats, and this should be applied in the PAS to the EUI64s too i.e. HEX64 pairs with colon separators This does exist, but the language is loose and confusing, and projects implemented different approaches.
			N. OADR Services: The PAS should also specify which OADR services are to be supported (if not all) and provide a message sequence diagram. This would overcome issues where some projects had implemented messages in sequences that included optional services that other projects had not expected.
			O. Parsing: was a big issue, there needs to be PAS specific XSDs that direct how to implement the PAS reporting structures into the OADR reports with clarity on report naming and which attributes are mandatory for PAS e.g. Order_ID.
L2	**PAS 1878 Requirements**	**Requirement Specification:** Breaking the PAS down into a list of requirements was challenging with the informative and normative narrative but also repetition of requirement, sometimes at different levels. We experienced mixed interpretations of requirements across test participants which suggests that the way they are presented is an issue.	Consider developing a list of headed normative requirements as an annex to complement the informative and normative text in the main specification to reduce the interpretation risk and provide a reference point.
L3	**PAS 1878 Requirements**	**Implementing Query Resolution:** Evolving understanding of PAS 1878 requirements impacted on Test Stub	Using conclusions of the Query process and/or ESA SWG output to update a single edited copy of PAS 1878 would allow the

		development and mixed interpretations of requirements across test participants. Throughout the project, multiple projects exhibited different opinions about a given technical solution or requirement. Some of these were dealt with by the Query process or the ESA Technical Working Group (TWG). However, there were cases of variations in interpretation even after issues had been treated by the Query process or SWG. This caused delays in project timelines.	projects to access a single, unambiguous, reference source. Maintaining an amended set of specifications (updated according to consensually agreed conclusions) would help with the efficiency of development and with any subsequent specification update/amendment.
L4	**PAS 1878 Requirements**	**Architecture Guidance:** Remote CEMs and smart functionality of ESAs were allowed within this programme. The projects implement a range of architectural variations – some: - are "in-premises" only, - place particular PAS 1878 roles (e.g. CEM) in the cloud, - use hybrid (in-premises and cloud) implementations of roles (e.g. ESA). When the delineation of roles or interfaces is clear, this is generally not an issue. When delineation is not so clear, then there is a possibility that the architecture itself does not meet some of the high-level PAS 1878 requirements (e.g. exchange of CEM or ESA).	Consider including further specification or guidelines in PAS 1878 with respect to in-premises, distributed and cloud architectures in relation to CEMs and smart functionality of ESAs.
L5	**PAS1878 Annex F and G**	**OpenADR Profile:** There were significant gaps in Annex F outlining the use of OpenADR and Annex G which provided examples of XML. The majority of issues experienced in testing was related to the implementation of Open ADR and XML design.	It is recommended that the implementation of the OpenADR protocol is more fully defined in the 2nd edition of the PAS by creating a PAS OpenADR Profile.
L6	**OpenADR Certification**	**Certification Vs Compliance:** Open ADR Certification was not a requirement of the programme, but it was stated that projects must comply with it. This statement caused confusion across the programme there was not a clear definition of compliance, and the PAS does not use all the available services.	The PAS will need to be very clear if OpenADR certification is required and / or a definition or guidance on what compliance is and regulation and policy will need to be clear how to achieve it.

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L7	**OpenADR Certification**	**Test Tools:** The Quality Logic Test Harness used by test houses to independently provide certification of certification is not aligned to the PAS requirements. Depending on what the certification requirement is in the 2nd edition there needs to be a mechanism for parties to validate their compliance, either by self-declaration or independent testing. Not having such a mechanism presents a risk to interoperability.	Consider how and what mechanism can be used to support the future development of DSR solutions. One option is an update to the QLTH to accommodate the PAS OpenADR profile, another option is to continue to develop the SMS Test Stubs and Test Cases as they have become a reference point in the IDSR programme, a third option may be to commission the development of a new test tool to support the 2nd edition of the PAS.
L8	**DSR Solution Architecture**	**Cloud Based CEM & Smart Function:** Allowing DSR solutions to host the smart function of the ESA in the cloud may have implication / risk to the customer journey and creates an additional communication interface not recognised by the PAS.	Analysis of the potential risk the consumer journey should be considered if this is to be allowed in the 2nd edition of the PAS.
L9	**DSR Solution Architecture**	**Firmware Management:** The firmware management requirements in the 1st edition of the PAS are centric to an in premises CEM and ESA however remote cloud based CEM & smart functions of ESA were permitted. The requirements set out in the PAS were not appropriate for cloud-based systems.	Further clarity should be provided in the 2nd edition relating to the firmware management requirements of cloud based CEM and smart function components.
L10	**DSR Solution Architecture**	**Hierarchy of Control:** Lack of clarity on hierarchy of control. In some solutions there were up to 4 interfaces that had user settings that impacted the ESA. It was not clear which controls had primacy (If any) or if they all fed into or triggered new profiles if adjusted.	Related to finding L1, B & C and the need to have clear user interface requirements and be clear about the expected consumer journey. This issue is likely to result in a poor consumer experience and risks confusion on ESA Behaviour.
L11	**Testing Requirements**	**Clear Testing Objective:** One of the main testing requirements of Lot 1 was the design, development and implementation of a Conformance Testing Scheme. Due to the immaturity of the PAS, subsequent DSR solutions and delays, it was necessary to change the principles of conformance testing from having very binary threshold to being more pragmatic creating an environment the projects and programme could	The change in approach was necessary and evolved over a period however, taken a more pragmatic and exploratory approach provided a learning environment which seemed more appropriate than a regimented conformance regime. Any future requirements to support the 2nd edition of the PAS or future assurance scheme should consider a preliminary exploratory activity and collaborative interoperability events which not only provides learning opportunities but provides more transparent

		learn from rather than a rigid entry and test process.	evidence of maturity and progress of the solutions.
L12	**Testing Requirements**	**Impact of Multiple ESAs:** One of the multiplying factors of the scope of testing for Lot 1 was number of ESA types. Whilst this seems reasonable, the effect different types of ESAs had on testing the conformance of PAS requirements and OpenADR messages was very negligible as there was a single development of Interface A (see section 8.1) the effect of the multiplying factor was significant from a time perspective with little value.	Consider if multiple ESAs is a valid multiplier of testing scope. Any future conformance / assurance scheme should focus on testing the defined interface and avoiding re-testing the same interface because multiple ESA types are present. This is particularly important if the CEM and smart function is cloud based.
L13	**Cyber Security**	**Immature Cyber Security Implemented:** The Stream 1 projects were mainly found to be at an early development stage, only a minimum amount of cyber security requirements was implemented. None of the projects had procured any security testing and only one project had undertaken a security risk assessment as stated in Clause 6 of the PAS, most projects were not aware it was a requirement.	The 2nd Edition of the PAS should consider if the Cyber Security requirements are proportionate to the risk that aggregated ESAs pose to critical national infrastructure. It is our view that cyber security should be subject to specific testing and independent assurance. Further consideration needs to be given to the smart functionality of the ESA being allowed to be cloud based as this changes the model. If the direction of travel is more functionality within the cloud, then the implication of that should be brought into focus of the cyber security requirements introducing best practice principles for cloud solutions.

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