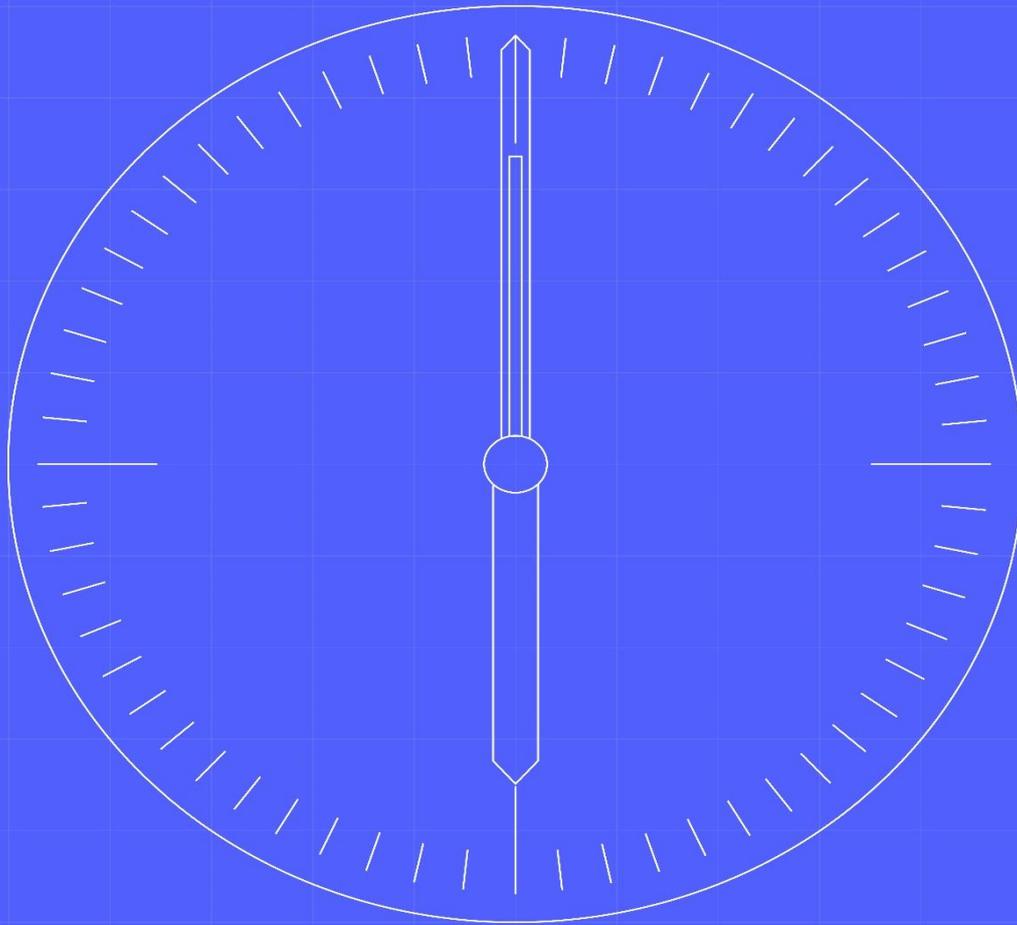




# E2E Testing & Integration Strategy



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**Kate Goodman**

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## 1.1 Change Record

Date	Author	Version	Change Detail
29 April 2022	Kate Goodman	1.0	First definitive version

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## 1.2 Reviewers

Reviewer	Role
n/a	

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## 1.3 References

Document/Link	Publisher	Published	Additional Information
<a href="#">MHHS Transition Timetable</a>	Ofgem	April 2021	

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## 1.4 Terminology

Term	Description
	For terminology, see programme glossary on the MHHS portal: <a href="#">Programme Glossary (sharepoint.com)</a>

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## 2 Executive Summary

The Market-wide Half Hourly Settlement programme (MHHS) when completed will contribute to a more cost-effective electricity system, encouraging more flexible use of energy and helping consumers lower their bills. This document describes the overall, end-to-end (E2E) approach to testing - the manner in which all parties involved in the MHHS programme will conduct testing. It spans initial testing of individual systems through to complete E2E tests ahead of the start of the Migration Period (where the new systems are progressively introduced and old systems progressively retired).

The document describes the major phases of testing leading up to the start of the migration period (each of which is composed of one or more test stages):

- **Pre-Integration Testing (PIT)**, where each component system (eg Data Integration Platform – DIP, Elexon Load Shaping Service, service provider's system) is tested in isolation by its owning organisation.
- **Systems Integration Testing (SIT)**, where all the component systems in the E2E MHHS landscape are integrated in a progressive manner and then tested. This testing involves all implicated central systems (MHHS DIP, CSS, DSP, DTN and Elexon Central Systems) and a small number of supplier, service provider, UMSO, Network Operator and Registration systems so that the overall E2E MHHS Design can be verified by executing full E2E scenarios. The MHHS IM (specifically by the Systems Integration team – SI team) is responsible for overall test management and co-ordination, including test scoping, defect management, environment configuration/release management and test assurance. Each organisation owning a system executes the required tests, which encompass functional, non-functional, operational and migration tests (each of these forming a different test stage).
- **User Integration Testing (UIT)**, where the majority of “users” (suppliers, service providers and (I)DNOs - all DSOs as defined in the BSC, i.e. all DNOs and all IDNOs) conduct their testing. There are two constituent test stages: Qualification and E2E Sandbox Testing. Each organisation must first pass the Qualification test (unless they have participated in SIT), which is necessary for participation in the live MHHS. Following this, they may conduct their own testing in the E2E Sandbox Testing stage to fully prove their system and business process changes.

These phases and stages largely correspond with those described in Ofgem's Transition Timetable. One main difference is that Ofgem's Connectivity and Basic Message Exchange stages have been replaced by a Component Integration stage where systems are incrementally added to the environment in a controlled manner. Additionally, there is now a SIT Migration test stage not identified by Ofgem.

Most suppliers and service providers will conduct PIT and then participate in Qualification, after which they may choose to conduct E2E Sandbox testing. A small number of suppliers and service providers will be needed to participate in SIT (and those who complete SIT will be deemed to have passed Qualification). Where suppliers or other parties contract independent software providers, these organisations may participate in SIT in lieu of the contract owner. As a principle, each component system must successfully exit PIT (based on exit criteria defined by the SI team in conjunction with the programme participants) before entering into either SIT or Qualification. The SI team will conduct assurance of the PIT testing.

A separate Testing Approach and Plan will be produced for each of the test stages by the party responsible for that stage of testing as set out in subsequent sections of this document. This will include details of the testing to be conducted and the detailed entry and exit criteria. In the case of Pre-Integration Testing, a separate Approach and Plan will be produced for each of the component systems under the co-ordination of the SI team.

A risk-based approach to testing will be adopted, with the depth and breadth of testing determined by assessment of operational and business risk, as agreed between the SI team and the programme participants. The test coverage of each phase will be demonstrated by the use of requirement traceability matrices, where the controlling requirements for a phase are listed and a mapping given to the relevant test cases.

Assurance will be based on the “three lines of defence” model, where the first line is self-assurance (for example peer review of test scripts within the team producing the scripts), the second is assurance by a member a different part of the MHHS programme (for example SI assurance of selected programme parties' test execution) and third is independent assurance (carried out by the Independent Provider of Assurance – IPA – appointed by Ofgem).

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## 3 Introduction

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### 3.1 Context

This document sets out the manner in which all parties involved in the MHHS programme will conduct testing during the Design, Build and Test (DBT) phase of the programme. It should be read in conjunction with the MHHS-DEL300 – Test Data Strategy document.

This Testing Strategy has been developed in conjunction with the MHHS Testing & Migration Advisory Group (TMAG, formerly TAG) and has taken on board lessons learned in both the Smart Metering Implementation Programme (SMIP) and the Faster Switching Programme (FSP).

The Strategy described in this document recognises the timelines in the [Ofgem Transition Timetable](#). No timings are given explicitly in this document because these will be determined in the re-baselining of the programme plan which will follow the publication of this Strategy.

The testing described in this document will be elaborated in further Testing Approach and Plan documents (one for each test stage). The testing will be divided according to its purpose into a number of phases and further sub-divided into test stages. A Plan will be produced for each test stage by the responsible party or provider. For PIT, each programme participant will produce a Plan. For SIT, the SI team will produce a Plan for each stage. For UIT, the SI team will also produce an overall Plan for each of Qualification and E2E Sandbox testing and each programme participant will conduct testing according to the relevant Plan.

Where this document mentions a programme participant, this should be read as including any software providers to those participants. The document references programme participants to reflect that the responsibility for correctly-functioning systems and processes remains with them.

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### 3.2 Reviews and approvals

This document is being reviewed internally within the programme by members of the LDP, the SRO team and by TMAG. It is also open to review by any member of the industry and is being socialised by various means to ensure as wide a coverage as possible. TMAG will be the approving body.

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### 3.3 Change forecast

This document will be reviewed and where applicable, updated when the following are available:

- Baselined E2E MHHS Design; and
- Re-baselined MHHS Programme Plan.

The SI team will own this document and keep it up to date, with review and approval by MHHS programme governance as appropriate. Each new version supersedes the previous version in its entirety.

Updates to this document will follow the review and approval process outlined above.

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### 3.4 Summary of changes

This is the second draft (the first having been a slide deck of principles which was agreed at TMAG). The description of the test environments has changed since draft one.

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## 4 Scope and Objectives

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### 4.1 Objectives

The objectives of this Strategy are to:

- Define the manner and sequence in which the component systems will be integrated and identify supporting test harnesses required (test “stub” software developed solely for the purpose of test support).

- Define the testing, test management and assurance activities necessary to demonstrate that the E2E solution meets the requirements set out in the E2E MHHS Design.
- Define the principal objectives and responsibilities of each test phase.
- Mitigate the risks of poor-quality components, systems and processes being introduced into live operation.
- Ensure that the level of testing assurance meets the requirements of key stakeholders.
- Identify the responsibilities and obligations of those involved in testing.
- Act as the primary point of reference for all testing and testing assurance questions, with further details being provided in the individual Testing Approach and Plan documents relating to each test stage.

## 4.2 Scope

The scope of testing described in this document covers all testing up to the point of the start of the migration period. Facilities for enduring testing post-go-live will be covered as part of the enduring Qualification process.

Principles underpinning the way in which testing will be conducted are:

- Changes to a system will first be tested on that system in isolation by the responsible provider.
- Systems will be integrated by incrementally adding individual (or groups of) systems to the integrated environment in a controlled manner using a logical sequence.
- Testing the integration of the component systems implicated in MHHS will be managed by the SI team within the MHHS IM.

Testing execution will be conducted by the programme participants responsible for the systems/services under test, acting together as co-ordinated by the SI team.

For UIT, the SI team will manage the provision of a testing service for programme participants (PPs), where the PPs may connect and test against central systems.

The scope of the testing is described in Figure 1 - Scope of MHHS E2E testing below.

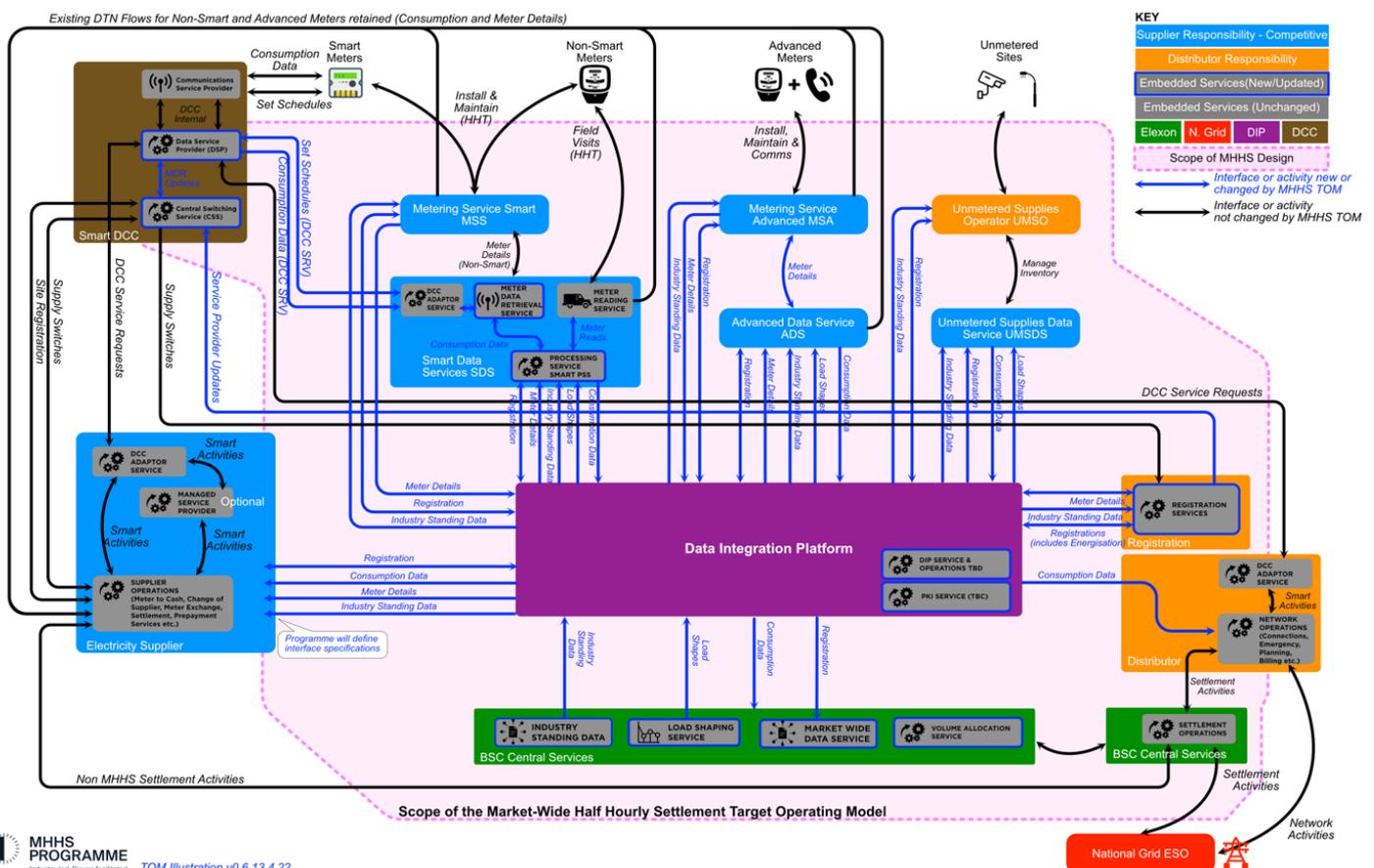


Figure 1 - Scope of MHHS E2E testing corresponds to scope of Target Operating Model

The scope of MHHS testing corresponds to the MHHS Design scope and is shown in the light pink shaded area. Note that where the scope partially covers a component (eg Distributor Services), the interfaces to/from that component are within the scope of testing. The DTN is not shown but will be used in the SIT tests where its use is necessary to demonstrate E2E scenarios, as will the internet-based channel to/from CSS. MHHS SIT will test the E2E functionality where the systems act together. Verification of the detailed functionality of each component is responsibility of the component’s service provider during their PIT. Bi-directional arrows show that data flows in both directions and uni-directional arrows show flow in one direction.

Organisations impacted by MHHS who will take part in the testing described in this document and as shown in the pink area of the diagram are referenced as programme participants. Programme participants consist of:

- Suppliers;
- Service providers;
- (I)DNOs; and
- Central parties.

Suppliers (and/or service providers with whom the suppliers have contracted) will provide the services shown in light blue. Central parties are organisations responsible for central systems and services. These are shown in amber, green and brown on the diagram. They are:

- Data Integration Platform service provider (responsible for the DIP);;
- DCC (responsible for both Smart Metering and Central Switching Service);
- Elexon (responsible for Elexon Central Systems, which comprise Load Shaping Service, Market Data Service, Volume Allocation Service, Industry Standing Data Service and BSC Settlement Operations);
- Electralink (responsible for the Data Transfer Network – DTN ) – not shown on the diagram;
- St Clements and C&C, together with the (I)DNOs (responsible for SMRS); and
- UMSOs (responsible for the UMSO services).

### 4.3 Test phases and stages

The testing has been divided into a number of test phases to support the above principles. Each phase may have more than one constituent test stage(s). See Figure 2 - Test phases and stages below.

Phase	Stage	Purpose (verifies that...)	Under test	Involved
Pre-Integration Test (PIT)	Pre-Integration	Systems work as designed when running in a standalone manner	PP's own systems	
Systems Integration Test (SIT)	DIP (incl PKI)	Systems integrate as designed	DIP, Elexon Central Systems, Supplier Services, Data Services, Meter Services, Registration Services, UMSO Service, NO Services, DSP, CSS, DTN	
	Central Systems			
	Supplier, Data Services			
	Meter, Registration, UMSO, NO Services, DSP, CSS, DTN			
	Functional	Systems support full E2E business processes		
	Operational	Systems support full operational processes		
	Non-Functional	Systems' NF characteristics are as designed		
	Migration	Migration processes give correct business outcome		
User Integration Test (UIT)	Qualification	Systems support requirements for qualification	Supplier, Data, Meter, Registration, UMSO, NO Services	DIP, Elexon, DSP, CSS, DTN
	E2E Sandbox	Systems support full business & operational processes		

Figure 2 - Test phases and stages

The proposed set of test phases and their constituent stages is:

- **Pre-Integration Testing (PIT)**, conducted by the programme participant responsible for the relevant system.
- **Systems Integration Testing (SIT)**, where the testing is managed by the SI team and executed jointly by the SI and all PPs responsible for the in-scope systems and which comprises:
  - **Component Integration Testing**, where all components of the MHHS E2E solution are integrated and tested for compliance with the interface specifications and codes of connection. This includes step-by-step integration of the DIP (including PKI), central systems, supplier services, Data Services, Metering Services, Registration Services, UMSO services, network operator services, DSP, CSS and DTN.
  - **Functional SIT**, where together, the systems and their interfaces are tested E2E for compliance with the E2E MHHS Design, using pre-defined E2E business scenarios.
  - **Operational SIT**, where the central systems' operational functions and processes are tested (including their service management solutions and Business Continuity/Disaster Recovery). Supplier and service provider systems may be needed to support testing but will not themselves be under test.
  - **Non-Functional SIT**, where the non-functional characteristics (including performance and security requirements) specified in the E2E MHHS Design are tested in an E2E manner. (Note that there are elements of non-functional testing in other stages but this is the place where E2E is conducted.)
  - **Migration SIT**, where the migration process specified in the E2E MHHS Design is tested, starting with the "as is" systems and moving through the migration steps to arrive in the final "to be" state. Migration will be a critical phase of the programme where the automated migration of large volumes of data will be tested functionally and non-functionally. The result of the testing will inform the decision on the length of the migration window (a balance between the risk of trying to complete too quickly and allowing the overall programme timeline to be too long and costly). Both central (market infrastructure) and supplier/service provider systems will be needed for Migration SIT.
- **User Integration Testing (UIT)**, where testing is conducted by PPs against the central systems and comprises:
  - **Qualification** to verify the PP's fitness to take part in the new arrangements.
  - **End-to-End Sandbox Testing**, where each PP may conduct any other testing it wishes, to verify its own system.

Each phase is described in detail in the following sections.

The dependencies between the test stages are shown in Figure 3 - Dependencies between test stages, below. For the dependency between Qualification and E2E Sandbox, this shows that for a given programme participant, Qualification must be completed before that participant can enter E2E Sandbox. It does not mean that all Qualification must complete before E2E Sandbox can begin.

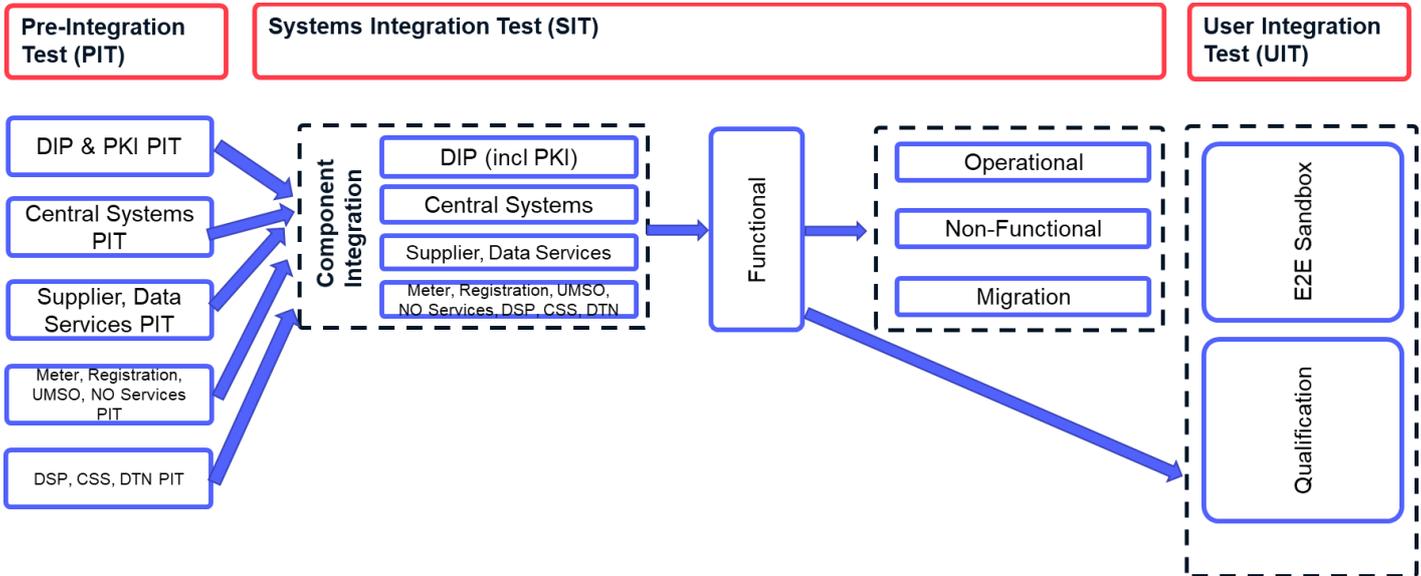


Figure 3 - Dependencies between test stages

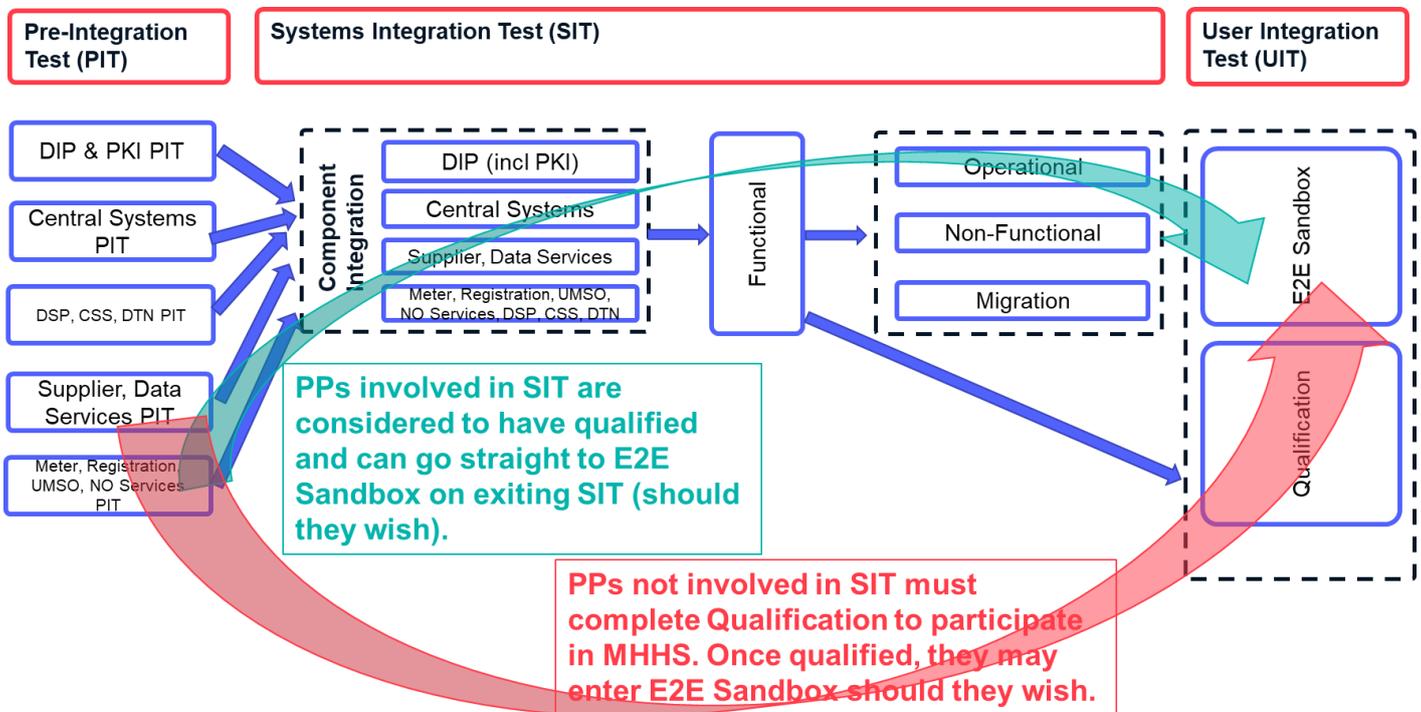


Figure 4 - PPs' paths through testing

#### 4.4 Testing within a phase

Each phase will comprise a number of different types of testing:

- **Functional;**
- **Non-functional,** comprising:
  - Performance;
  - Load;
  - Resilience; and
  - Security.

- **Regression.**

Some aspects of security testing, such as penetration testing of the environments for SIT and UIT, will be scoped and assured by the MHHS Security team. The definition of those tests will be contained in the Testing Approach and Plan for the test stage. The party responsible for the environment will be expected to conduct the penetration testing and the MHHS Security team will monitor and assure the completion of this testing. This approach differs from that taken in Ofgem's Transition Timetable, where Security Testing is a specific stage.

Regression testing would be expected to be automated as far as is reasonable.

Performance testing will be carried out in the SIT Non-Functional test stage to test performance in an end-to-end manner across the whole of MHHS. PPs are expected to carry out their own performance (and other non-functional) testing in PIT. The UIT environment will not be expected to be suitable for performance testing.

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## 5 Test Phases

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### 5.1 Pre-Integration Testing

PIT will be performed by all users of the new settlement arrangements to validate every system or service that is included in the E2E MHHS design (and its interfaces in/out) for compliance with its functional and technical requirements. This includes back-office systems if affected. The system/service may have several components and PIT refers to the testing conducted when those components are all integrated. The programme recognizes that PPs may follow different development methodologies but assumes that there will always be a final test where all components are tested for business scenarios in an end-to-end manner (often referenced as User Acceptance Test - UAT). PIT refers to this UAT and not to any earlier tests carried out as part of development.

PIT is the responsibility of each individual party, using their own systems, test environments, test data, test artefacts (scenarios and scripts), test processes, test management tool and defect management process. The PP is expected to comply with good industry practice. The MHHS programme will provide central service simulators (for LSS and MDS) and a consumption data generator, which will be available to all PPs should they choose to use them.

PIT will include functional, non-functional and regression testing. It will test core business processes, ensuring changes due to the implementation of the MHHS programme have been implemented correctly (including interfaces to other systems within the scope of the MHHS TOM).

An MHHS test completion report will be provided by all participants to record the outcome of their PIT testing and will form part of the exit criteria from PIT and entry criteria for their next test phase. For most participants, this report will be brief but will be more detailed for those participants taking part in SIT (eg Elexon Central Systems or SIT-participating suppliers and service providers). The SI team intend to provide guidance on interface tests which will be required as a minimum to exit SIT (and there will possibly be some automated procedure to verify this).

Assurance of the PIT activities and evidence will be the responsibility of the MHHS IM (for SIT participants), Qualification team (for non-SIT participants) and IPA (for both SIT and non-SIT participants). Where appropriate, the MHHS IM and IPA will take account of any other assurance carried out on the PIT (for example an energy supplier assuring its service provider or a third party assuring an energy supplier). Assurance at this point is important to give confidence ahead of SIT (or Qualification).

Note that this document does not deal with "pre-qualification". A successful PIT will be one of the items required in pre-qualification and since this document is a testing strategy, only the PIT is covered. The other elements required for pre-qualification will be described separately by the Qualification team.

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### 5.2 Systems Integration Testing

SIT will be performed by the service providers of the central systems (Elexon, Electralink, DIP operator, DSP and CSS) together with a small number of volunteer suppliers, metering service providers, (I)DNOs and service providers and coordinated by the MHHS IM (SI team). The programme will need a minimum of two parties to participate in SIT for each of the following categories:

- Smart Metering Services

- Smart Data Services;
- Advanced Metering Services
- Advanced Data Services;
- UMSO;
- Registration Services;
- Network Operations; and
- UMS Data Services.

The expectation is that sufficient organisations will make themselves available to participate in SIT if encouraged to participate on a voluntary basis. Participation in SIT will give the organisations involved the advantage of being able to conduct their testing earlier than if they were going straight from PIT into Qualification testing and therefore allowing more time to iron out defects and achieve a stable system, being ready for starting migration earlier.

The SI team is responsible for the timely and successful completion of SIT. In practice, this means the SI defines and prioritises the test scenarios (including regression scenarios), defines the test data, orchestrates the running of the tests and manages defect resolution. The SI team also supplies a number of pieces of software (test harnesses) to support testing (such as to generate large quantities of consumption data). The Test Data Strategy will give further details about test data in SIT and UIT. Each participant will be responsible for defining detailed test steps, the provision of their own test environments and the execution of their processes for SIT. The SI will manage SIT using Azure DevOps (ADO, which is the Microsoft equivalent of Jira), in which it will record the test scenarios. All participants will be required to develop their test scripts and record their execution in ADO. The tests may be automated or manual at the PP's discretion but where end-to-end scenarios are being tested which involve sequenced actions by different PPs, the scope for automation may be limited. The SI team will provide access to ADO via the programme portal as well as appropriate training in the use of ADO ahead of SIT commencement, in order for programme participants to make effective use of the tool. The SI team will also provide import/export facilities in a simple form, to allow PPs to use their own test management tool to manage their testing and to be able to upload results into ADO.

SIT will include functional, non-functional, operational and migration testing. Each of these elements will have a set of regression tests to verify change/defect fixes. SIT will verify that interfaces between components and E2E processes operate as specified in the MHHS E2E Design. It will include negative tests and tests will be prioritized according to an assessment of operational and business risk.

A test completion report for each stage is produced by the SI team, drawing together the test results from all of the participating organisations, as recorded in ADO. An overarching MHHS test completion report will also be provided by the SI and this will need to be approved by the Level 3 governance body Testing and Migration Advisory Group (TMAG).

Internal assurance of the SIT activities and evidence will be the responsibility of the MHHS IM and the IPA will conduct independent assurance. The MHHS IM will conduct assurance on all SIT parties, at a depth and breadth that is appropriate.

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### 5.3 User Integration Testing - Qualification

Qualification must be performed by all participants (other than the central systems providers) who wish to participate in the market. This comprises all SDS, ADS, UMSSDS, MSS, AMS, suppliers (for their interfaces), UMSO, Registration and Network Operations for (I)DNOs. Full details of Qualification will be described in the Testing Approach and Plan for Qualification.

Each programme participant is responsible for ensuring their successful completion of Qualification. The SI will specify the scenarios to be tested (based on MHHS E2E Design) and will ensure the availability of relevant test harnesses, a test environment and appropriate data against which each PP can test. Each PP must demonstrate network connectivity prior to the start of its Qualification testing. Each participant will be responsible for defining the detailed test steps and recording the test execution in ADO. The SI will also manage the schedule of testing, since it is unlikely that all participants will be able to test simultaneously.

SIT proves the E2E design works through testing with parties; Qualification proves individual parties comply with the E2E design. Qualification will include functional and non-functional components as well as the ability to correctly perform the migration steps. It will contain both “happy path” and negative testing. It will verify that the participant’s systems interact correctly with the central systems. It may contain an element of business process testing. A participant who successfully completes SIT will be deemed to have completed Qualification.

An MHHS test completion report will be provided by each participant and this will need to be approved by the MHHS IM. Once a participant has successfully completed Qualification, they may use the E2E Sandbox for further testing.

Assurance of individual participants will be as described above under “Qualification exit”. In addition, the SI team will conduct selective assurance, as will the IPA.

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## 5.4 User Integration Testing – E2E Sandbox

E2E Sandbox testing is available to all participants (other than the central systems providers) once they have completed Qualification, should they wish to participate.

Each programme participant is responsible for their own E2E Sandbox testing, including defining the scenarios and scripts. The SI will ensure that a test environment and appropriate data are available to participants. The SI will manage the schedule of testing if necessary (to the extent of allocation of a participant to a test window should capacity constraints mean that not every organization can test simultaneously) and the defect resolution process for any defects in the central systems.

E2E Sandbox testing can be any testing the participant wishes to undertake (with the exception of volume/performance testing and any potentially destructive testing). It allows a participant to thoroughly test their systems and business processes to the degree they deem appropriate. This is a crucial test stage – the participants each know their own businesses and because historically it has flushed out many important issues.

There is no formal programme exit for E2E Sandbox testing. Each participant should set their own exit criteria and measure whether they have been achieved.

Each participant is responsible for conducting their own assurance of E2E Sandbox testing.

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## 5.5 Participation of different organisations in PIT, SIT and UIT

Figure 5 - Participation of different organisations in PIT, SIT & UIT, below, shows which organisations will participate in each of the test stages in PIT, SIT and UIT.

All MHHS participants will be required to complete their own internal PIT.

The central systems will be required to participate in SIT. A selected small number of metering services, data services and suppliers will be needed to participate in SIT. Selected (I)DNOs will also be needed to participate in SIT.

In UIT, the central systems will be required to participate in that they will provide test systems as a service on which other PPs can test. All PPs which are not central systems will be required to successfully complete Qualification (unless they have already successfully completed SIT, which is considered equivalent). All PPs which are not central systems may conduct E2E Sandbox testing if they choose to do so.

BSC Role	Responsible Organisation(s)	Body(ies) currently governing qualification	PIT			SIT			UIT	
			PIT	Component Integration	Functional	Operational	Migration (incl migration-related NF)	Non-Functional	Qualification	E2E Sandbox
MSS (Metering Service Smart)	service provider	BSC, REC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
SDS (Smart/Non-Smart Data Service)	service provider	BSC, REC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
MSA (Metering Service Advanced)	service provider	BSC, REC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
ADS (Advanced Data Service)	service provider	BSC, REC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
UMSDS (UMS Data Service)	service provider	n/a	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
domestic supplier	supplier	BSC, REC, SEC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
non-domestic supplier	supplier	BSC, REC, SEC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
SmartDCC - DSP	DCC	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
SmartDCC - CSS	DCC	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
ISDS (Industry Standing Data Service)	Elxon	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
LSS (Load Shaping Service)	Elxon	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
MDS (Market-wide Data Service)	Elxon	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
VAS (Volume Allocation Service)	Elxon	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
Settlement Operations	Elxon	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
UMSO	(I)DNOs	BSC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
Network Operations	(I)DNOs	BSC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
Registration Services	(I)DNOs	BSC, REC	Y (all)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (selected)	Y (if not in SIT)	Y
DIP	MHHS	n/a	Y	Y	Y	Y	Y	Y	Y (service)	Y (service)
PKI	MHHS	n/a	Y	Y (test certs?)	Y (test certs?)	Y (test certs?)	Y (test certs?)	Y (test certs?)	Y (service)	Y (service)

Figure 5 - Participation of different organisations in PIT, SIT & UIT

## 6 Test Management and Organisation

### 6.1 PIT

Each programme participant will be responsible for planning, managing and executing its PIT testing (which will need to meet defined entry and exit criteria and with a defined scope). Each programme participant will use and manage its own processes, staff, test environments, test data, test tools and test labs for PIT, noting the need to report progress to the MHHS IM. Regardless of the development methodology used, there will be an activity performed towards the end of development, where the programme participant performs business and/or acceptance testing of its integrated solution. This is sometimes called “system testing”; in this document it is referenced as PIT.

Each programme participant undertaking PIT will provide the following to the MHHS SI team:

- Testing Approach & Plan documents ahead of test execution;
- Regular progress reports in the run-up to and during test execution for PIT; and
- A test completion report at the end of each stage of test execution, which demonstrates traceability to the requirements described in the MHHS E2E Design.

The SI and the Qualification teams will assure PIT, as described in section 11 - Test Assurance.

The following RASCI matrix shows respectively which party is Responsible, Accountable, Supporting, Consulted or Informed.

Activity/Deliverable	Programme participant	SI team	Qualification team	IPA
Approach & plan	R, A	C	-	-
Test scenarios	R, A	I	-	-
Test scripts	R, A	-	-	-
Test harnesses	R, A	R, A	-	-
Test infrastructure/ environments	R, A	-	-	-
Test data	R, A	S	-	-
Test execution	R, A	I	-	-
Test preparation status report	R, A	I	-	-

Activity/Deliverable	Programme participant	SI team	Qualification team	IPA
Test execution status report	R, A	I	-	-
Test issue & defect management	R, A	I	-	-
Test completion report: <ul style="list-style-type: none"> <li>• Functional</li> <li>• Non-functional</li> <li>• Regression</li> </ul>	R, A	C	-	I
Readiness self-assessment for next test stage	R, A	C	I	I
Assurance	S	R, A	I	R

Table 1 - RASCI for PIT

## 6.2 SIT

The SI team will be responsible for planning, scoping, assuring and co-ordinating the execution of SIT. The individual programme participants involved in SIT will define detailed tests and execute the testing.

The test stages within SIT will require test environments, test data and test harnesses to be shared across the programme participants involved under a common set of processes (defined by the SI team). For each test stage within SIT, the SI team will produce a Testing Approach and Plan document covering:

- Roles and responsibilities;
- Definition of test success criteria;
- Entry and exit criteria;
- Set-up and operation of the test management tool (ADO);
- Tracking and reporting of test progress;
- Identification and design of the test scenarios to be covered;
- Description of test prioritisation rationale;
- Design and sourcing of the supporting test data;
- Participation in test script preparation and execution;
- Co-ordination of joint test preparation and execution activities;
- Staffing levels required to support test preparation, test execution and issue resolution;
- Process for issue resolution, including escalation process;
- Plans for establishing connectivity between systems participating in SIT;
- Procedures and privilege rights for the access to test environments;
- Scheduling the usage of test environments; and
- The test harnesses to be used.

The SI team will provide the SRO team and all participants with:

- The test approach and plan document ahead of test execution;
- The ADO tool to manage the testing, appropriately configured and with training available;
- Regular progress reports in the run-up to and during test execution; and
- Test completion reports at the end of each stage of test execution.

Activity/Deliverable	Programme participant involved in SIT	SI team	Qualification team	IPA
Approach & plan	C	R, A	-	-
Test scenarios	C	R, A	-	-
Test scripts	R	S, A	-	-
Test harnesses	R, A	R, A	-	-
Test infrastructure/ environments	R	S, A	-	-
Test data	S	R, A	-	-
Test execution	R	A	-	-
Test preparation status report	S	R, A	-	-
Test execution status report	R	A	-	-
Test issue & defect management	S	R, A	-	-
Test completion report: <ul style="list-style-type: none"> <li>• Functional</li> <li>• Non-functional</li> <li>• Regression</li> </ul>	S	R, A	-	I
Readiness self-assessment for next test stage	R, A	C	I	I
Assurance	S	R, A	I	R

Table 2 - RASCI for SIT

Note that the PPs participating as Data Services will be required to provide test harnesses to simulate the interaction with Metering Services until the Metering Services are added into the test environment.

### 6.3 UIT Qualification

For Qualification testing, the SI team will provide the scope and scenarios (on a per user type basis). The SI team will also allocate test data for each programme participant to use. The SI team will also manage the PPs' use of the test environment, possibly by the assignment of PPs to testing "tranches". The programme participant will define the detailed test cases necessary to adequately cover the defined scenarios. The programme participant must provide its own test environment and a pre-requisite will be that it is connected to test environments provided by central system providers (eg DIP provider and Elexon Central Systems). The SI team will be responsible for managing the provision of the central parties' test environments. Test harnesses will be provided by the SI team and/or the programme participant, as described in section 10 - Test Harnesses. The programme participant will execute the tests and report on preparation and execution progress and completion. The Qualification team will carry out any necessary deep-dive assurance. The SI team will manage the test issues, assigning responsibility for fixing to the appropriate party as part of the triage process.

The SI team recognises that each PP will have its own test management tool which they will use to manage their testing, so the SI will provide a simple interface to ADO which can be used to export test scenarios and import test scripts and execution results. This will allow each PP to manage its testing in its normal way but still provide the benefits of all the test evidence being held centrally where it can be monitored and assured.

Activity/Deliverable	Programme participant	SI team	Central programme participant	Qualification team	IPA
Approach & plan	R, A	-	-	I	-
Test scenarios	S	R, A	-	S	-

Activity/Deliverable	Programme participant	SI team	Central programme participant	Qualification team	IPA
Test scripts	R, A	-	-	-	-
Test harnesses	R, A	R, A	-	-	-
Test infrastructure/ environments	R	A	R	-	-
Test data	S	R, A	S	-	-
Test execution	R, A	-	S	S	-
Test preparation status report	R, A	-	-	I	-
Test execution status report	R, A	-	-	-	-
Test issue & defect management	R, A	R, A	R, A	C	-
Test completion report:					
• Functional	R, A	-	-	C	I
• Non- functional					
• Regression					
Readiness self- assessment for next test stage	R, A	I	-	I	I
Assurance	S	-	-	R, A	R

Table 3 - RASCI for UIT Qualification

Note that each participant is responsible and accountable for managing/fixing their own defects and issues. The SI team remains responsible for the overall issue management for centrally-raised issues, including their triage.

#### 6.4 UIT E2E Sandbox

For E2E Sandbox testing, the SI team will manage the provision of central parties environments necessary for each programme participant to establish a connection for conducting testing. The SI team will also allocate MPAN test data for each programme participant to use. The programme participant will define the scenarios and detailed test cases it wishes to cover. The programme participant must provide its own test environment and this will connect to test environments provided by central parties. Test harnesses will be provided by the SI team and/or the programme participant, as described in section 10 - Test Harnesses. The programme participant will execute the tests and report internally according to its own processes on preparation and execution progress and completion. The SI team will manage the test issues which are raised centrally (ie not those fixed by a PP in isolation), assigning responsibility for fixing to the appropriate party as part of the triage process.

Note that software providers (even ones without a client which is using the E2E Sandbox testing) will be able to participate in this test stage.

Activity/Deliverable	Programme participant	SI team	Central programme participant	Qualification team	IPA
Approach & plan	R, A	-	-	-	-
Test scenarios	R, A	-	-	-	-
Test scripts	R, A	-	-	-	-
Test harnesses	R, A	R, A	-	-	-
Test infrastructure/ environments	R	A	R	-	-
Test data	S	R, A	S	-	-
Test execution	R, A	-	S	S	-

Activity/Deliverable	Programme participant	SI team	Central programme participant	Qualification team	IPA
Test preparation status report	R, A	-	-	I	-
Test execution status report	R, A	-	-	-	-
Test issue & defect management	R, A	R, A	R, A	C	-
Test completion report	R, A	-	-	C	I
Readiness self-assessment for next test stage	-	-	-	-	-
Assurance	R, A	-	-	-	-

Table 4 - RASCI for UIT E2E Sandbox

Note that each participant is responsible and accountable for managing/fixing their own defects and issues. The SI team remains responsible for the overall issue management for centrally-raised issues, including their triage.

## 7 Test Process

### 7.1 General principles

Table 5 - Test process for PIT, SIT and UIT below summarises the responsibilities described in the previous section.

	PIT		SIT (all stages)		UIT - Qualification		UIT – E2ET	
Test basis	PP technical documents & MHHS interface specs	PP	MHHS E2E Design	MHHS	Qualification Test Scope & E2E Design	MHHS	PP tech/BP docs & MHHS E2E Design	PP
Test types	F/NF/Regression		F/NF/Regression/Ops/Migration		F/NF/Regression		Any	
Test scenarios	PP own process	PP	In ADO	MHHS	In ADO	MHHS	PP own process	PP
Test scripts (manual/auto)	PP own process	PP	In ADO	MHHS	In ADO	PP	PP own process	PP
Test data	MHHS test harness available for PP data generation	PP	MHHS-specified	MHHS	PP given range of data by MHHS	MHHS & PP	MHHS test harness available for PP data generation	MHHS & PP
Test execution	PP own process	PP	MHHS IM-co-ordinated process	MHHS & PP	PP own process	PP	PP own process	PP
Test management tool	PP own tool	PP	ADO	MHHS & PP	ADO	PP	PP own tool	PP
Issue & defect management	PP own process	PP	ADO for MHHS issues PP own process	MHHS & PP	ADO for MHHS issues PP own process	MHHS & PP	ADO for MHHS issues PP own process	MHHS & PP
Test completion report	MHHS Programme format	PP	MHHS Programme format	MHHS	MHHS Programme format	PP	MHHS Programme format	PP
Test assurance	PP own process & MHHS IM assurance	PP MHHS	MHHS IM assurance Independent assurance	MHHS IPA	MHHS IM assurance Independent assurance	MHHS IPA	PP own process & MHHS IM assurance	PP MHHS
Test exit approval	PP own process	PP	MHHS process	MHHS	MHHS process	MHHS	PP own process	PP

 Responsible party (where MHHS => MHHS IM)

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Table 5 - Test process for PIT, SIT and UIT

Note that for issue and defect management in SIT and UIT, issues are triaged by the SI team's established process and then will be allocated to an investigation/fix party. That party will manage the fix but SI team will have overall oversight of progress. "PP own process" is used for managing those defects on the PP's system which are not raised centrally.

### 7.2 Test coverage

The test scripts in each formal test stage will be mapped back to the corresponding design document and the requirements document by means of a requirements traceability matrix, so that the breadth of test coverage can be measured and verified. This will be done by the party responsible for producing the test scripts.

The depth of test coverage (i.e. how “thoroughly” each solution element is tested) will be determined by a risk assessment of:

- the importance to the market of the various solution elements; and
- the technical probability of test issues being present in each solution element.

The test coverage must also include an appropriate level of negative testing. Test coverage must be demonstrated by traceability back to requirements of the E2E MHHS Design. This must be shown initially prior to test execution commencement and then updated at test completion.

This approach applies to:

- all types of testing (eg functionality, security, performance);
- initial testing of solution elements during the PIT, SIT and UIT phases;
- testing of fixes and enhancements to these elements during the PIT, SIT and UIT test phases; and
- regression testing of these elements.

The risk assessment will be included in the relevant Testing Approach & Plan for each test stage.

---

### 7.3 Test prioritisation

Test prioritisation will be carried out according to:

- The need for the test to demonstrate basic functionality as a prelude to more complex testing or during the step-by-step integration of components; and
- The risk inherent in the functionality being tested.

Tests for basic functionality will be written and executed first and then the risk assessment will be used to prioritise test preparation and test execution activities for the remaining tests. For the risk-based prioritisation, each test will be prioritised by the relevant stakeholders in terms of its market impact (i.e. if the solution element covered by the test failed in live use, what would be the impact on the solution) and technical probability (i.e. how likely is it that test issues will be present in the solution element). This prioritisation will use a High, Medium, Low scale in order to group tests into three categories:

1. tests which cover solution elements that a) are very likely to contain test issues and/or b) would cause major market impact if they failed
2. tests which cover solution elements that a) are likely to contain test issues and/or b) would cause significant market impact if they failed
3. tests which cover solution elements that a) are unlikely to contain test issues and/or b) would cause only minor market impact if they failed.

Category 1 tests will be written ahead of category 2 tests, which will be written ahead of category 3 tests.

Category 1 tests will be executed ahead of category 2 tests, which will be executed ahead of category 3 tests.

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### 7.4 Test pass and fail

A test will pass if the actual result matches the expected result. Where this is not the case, a defect will be raised. If the defect is of severity 1-4 then the test will be set to “fail”. If the defect is of severity 5 (cosmetic), then the test will be set to “pass” but the defect must be included in a fixing plan which forms part of the agreed release plan. For a definition of the severities and other information on the way defects and issues are managed, see section 12 - Defect and Issue Management.

If the subsequent triage process determines that the defect has been raised in error (e.g. due to a misunderstanding), then the test result will be reset from “fail” to “pass”.

There is also the possibility of marking a test “descoped” by agreement of all parties concerned and on recording of a valid reason.

---

## 7.5 Test phase and test stage entry and exit criteria

This section describes generic test entry and exit criteria for test phases and test stages. Additional specific entry and exit criteria for each test stage will be described in the Testing Approach & Plan produced ahead of the relevant test stage.

The following generic entry criteria will gate the entry of all test phases:

- Testing Approach and Plan for the all test stages within the test phase have been signed off;
- Entry criteria for the first test stage within the test phase have been met; and
- Preceding test phase has been successfully completed unless there is an agreed plan to overlap test phases.

The following generic exit criteria will gate the exit of all test phases:

- All constituent test stages have exited successfully;
- Work-off plans for any outstanding defects have been agreed; and
- Compliance with requirements as described in the requirements traceability matrix has been fully demonstrated.

The following generic entry criteria will gate the entry of all test stages:

- Test scenarios have been signed off;
- Test scripts have been prepared, including traceability to requirements/design documents;
- Test harnesses, environments and data is ready;
- All relevant parties have confirmed they have resources with the requisite skills and system access to support the test stage (including skills and access for the MHHS tools such as ADO)
- Test governance is understood and relevant meetings/stand-ups set up in advance of stage commencement.

The following generic exit criteria will gate the exit of all test stages:

- All tests have been run to completion or any exceptions are documented and agreed;
- All category 1 and 2 tests have passed and the test pass rate is 85% or above or any exceptions are documented and agreed;
- There are no outstanding severity 1 or 2 defects or any exceptions are documented and agreed;
- The number of outstanding severity 3-5 defects on each system and the total number of severity 3-5 defects across all systems are within the limits agreed for each stage (as recorded in the Testing Approach & Plan for the test stage);
- Work-off plan for any outstanding defects has been produced and agreed;
- Test results and evidence has been captured in the test management tool;
- Defects have been captured in the defect management tool;
- Regression testing has been successfully completed; and
- Regression test pack has been prepared or updated.

---

## 7.6 Test suspension and resumption

During PIT, each PP may suspend and resume testing according to its own criteria and process.

During SIT and UIT, any PP has the right to suspend testing where it considers necessary, by agreement with the SI team. Testing will only recommence when agreed between the PP and SI team. Where the SI team believes there are reasonable grounds to suspend all testing, this can be done by agreement with the SRO.

Reasonable grounds for suspending testing may include any of the following:

- Application components are not available as scheduled;
- A testing issue prevents further useful testing from proceeding;
- A large percentage of planned test scripts for a given day fail and significant root cause analysis needs to be undertaken to establish the cause. The outcome of any root cause analysis activity may result in testing being suspended; or
- Test scripts to be executed are in a “blocked” status due to an identified testing issue.

Where testing has been suspended, either the SI team or the PP (as appropriate) will produce a test suspension report reflecting the cause of the suspension and the actions to be taken by whom and when in order for testing to resume – the test resumption criteria. Testing will only resume once the PP has demonstrated to the SI team or the SI team to the SRO that the test resumption criteria have been met.

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## 8 Test Governance and Reporting

### 8.1 Governance

The Testing and Migration Advisory Group (TMAG) is the MHHS programme Level 3 governance group dealing with all aspects of testing. It reports to the Level 2 Programme Steering Group (PSG) which is chaired by the MHHS SRO and this in turn reports to Ofgem at Level 1.

The TMAG is intended to have a number of Level 4 Working Groups reporting up to it. The Groups currently anticipated are:

- Data Working Group (DWG);
- Migration Working Group (MWG) (which will at some point incorporate Operational Testing);
- Environments & Configuration Management Working Group (ECMWG);
- Qualification & E2E Sandbox Testing Working Group (QESWG); and
- SIT Working Group (SWG)
- Non-Functional Testing Working Group (NFTWG).

Of these, the first two are in operation as of April 2022. The others will be stood up at the appropriate time.

TMAG will be responsible for approving the entry to and exit from each test phase. The only exception is where a particular test phase entry or exit has been identified as a programme-level milestone, in which case the approval will be given by either PSG or by Ofgem. This is the case for SIT entry.

Responsibility for approving the entry to and exit from test stages (within the test phases) will lie with the relevant Working Group. The Working Group will not approve individual participants' entry and exit but rather the overall entry and exit of a stage. For those programme participants involved in SIT, the SI team will provide approval of PIT completion and readiness to commence SIT for each participant. For all other programme participants, the Qualification team will provide approval of PIT completion and readiness to commence Qualification.

It should be noted that governance by other code bodies is also relevant. The SEC Testing Advisory Group (TAG) will remain responsible for all testing relating to the DSP (and other parts of Smart Metering). In particular, SEC TAG for the sign-off of the DCC's SIT completion report (which constitutes completion of PIT in MHHS terms).

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### 8.2 Reporting

#### 8.2.1 Principles

The progress of each test stage will be reported by the party responsible for managing that stage. For each stage there will be reporting covering:

- Test preparation;
  - Test execution; and
  - Test completion.
- 

### 8.2.2 Test preparation reporting

For each test stage, as soon as preparation begins, a monthly report will be submitted which will describe the state of readiness. For SIT and UIT, from one calendar month before the scheduled start of test execution, the report is submitted on a weekly basis (each Friday). The reports are submitted to the MHHS SI team who will collate and report to the SRO and TMAG on the overall readiness.

The progress reports will include:

- Actual number of test scenarios/scripts written, in progress and not started;
  - Requirements Traceability Matrix coverage achieved with the test scripts written to date;
  - State of readiness for:
    - Test data;
    - Test environment;
    - Test harnesses; and
    - Test team.
  - Progress against test stage entry criteria defined in associated Testing Approach & Plan;
  - Mitigation/management progress against key risks, dependencies and assumptions identified in the Testing Approach & Plan; and
  - Overall RAG status.
- 

### 8.2.3 Test execution reporting

Once test execution for a test stage has started, the responsible party will ensure that test execution progress is kept up to date in ADO (for SIT and Qualification). The SI team will then produce regular aggregate progress reports based on this information. For PIT and E2E Sandbox, the programme participant will produce their own reports on a monthly basis. The reports will be collated by the SI team for upward reporting to the SRO and TMAG. The reports will show:

- Actual number of test scripts executed vs. planned, cumulative trend;
  - Actual number of test scripts passed vs. planned, cumulative trend;
  - Actual number of open and closed test defects vs. planned, cumulative trend;
  - Actual number of test defects outstanding, split by severity;
  - Progress against test exit criteria defined in Testing Approach & Plan;
  - Progress against any work-off plan from previous test stage;
  - Risk, dependency and assumption status; and
  - Overall RAG status.
- 

### 8.2.4 Test completion reporting

Once test execution for each test stage has completed, the party responsible for that stage will produce a final test completion report. For PIT and E2E Sandbox, this will be individual programme participants; for SIT this will be the SI team and for Qualification, the SI will also create an overall report at the end of the stage. The report will show:

- Overview of testing undertaken;
- Actual number of tests run, passed, failed, not run;
- Explanation for any tests not run;
- Test defect IDs for failed tests;
- Number of test defects outstanding (if any), split by severity;
- Work-off plan for outstanding test defects (if any);
- Number and severity of test defects raised;
- Specification of test environment and release versions used; and
- Recommendations for tests to be included in the next test stage.

A draft of the test completion report will be issued 5 working days before the planned end of test execution.

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## 9 Test Environments and Configuration Management

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### 9.1 Introduction

For PIT activities, each programme participant is responsible for providing its own test environment(s) as it deems necessary in order to conduct the testing it plans. The SI team will monitor the progress of PIT preparation including environment provisioning via the programme participant's progress reports.

For SIT, the SI team will be responsible for specifying the necessary environments and for co-ordinating and monitoring progress on their delivery as well as conducting some selective assurance. Each organisation involved will be responsible for delivering the environment specified (under the guidance of the SI team). Details of the environments will be captured in the Test Environments Approach and Plan to be produced by the SI team following the approval of this Strategy document. The approach described here is intended to show the maximum number of environments needed. The Test Environments Approach and Plan will refine this approach and one of the considerations in developing the Approach and Plan will be to minimise the number of environments needed in recognition of the cost to a PP of maintaining multiple environments. Clearly, this will need to be balanced with the need to provide an adequate number of environments so that testing is not unnecessarily constrained.

For UIT, the SI team will be responsible for specifying the necessary environments for the central systems and for co-ordinating and monitoring progress on their delivery. The SI team will monitor programme participants' reported status with respect to ability to connect to the central SIT environment. The UIT environment is intended to support functional testing (including negative tests) but will not support volume testing.

Those parties taking part in SIT (all central systems and the SIT suppliers and SIT service providers) will need to provide the following test environments (in addition to any environments needed for PIT):

- SIT environment;
- Migration environment;
- UIT environment;
- Pre-production environment; and
- Production environment.

These will be used for different stages of testing, as shown in Figure 6 - Test environments for central systems and those non-central PPs participating in SIT below. The current Ofgem Transition Timetable will necessitate some parallel running of SIT Functional and SIT Migration, therefore separate environments are required for these. If in re-baselining the programme plan this parallel running is removed, then a single environment could potentially be

used first for SIT Functional and then for SIT Migration. This will be defined in detail in the Test Environments Approach and Plan.

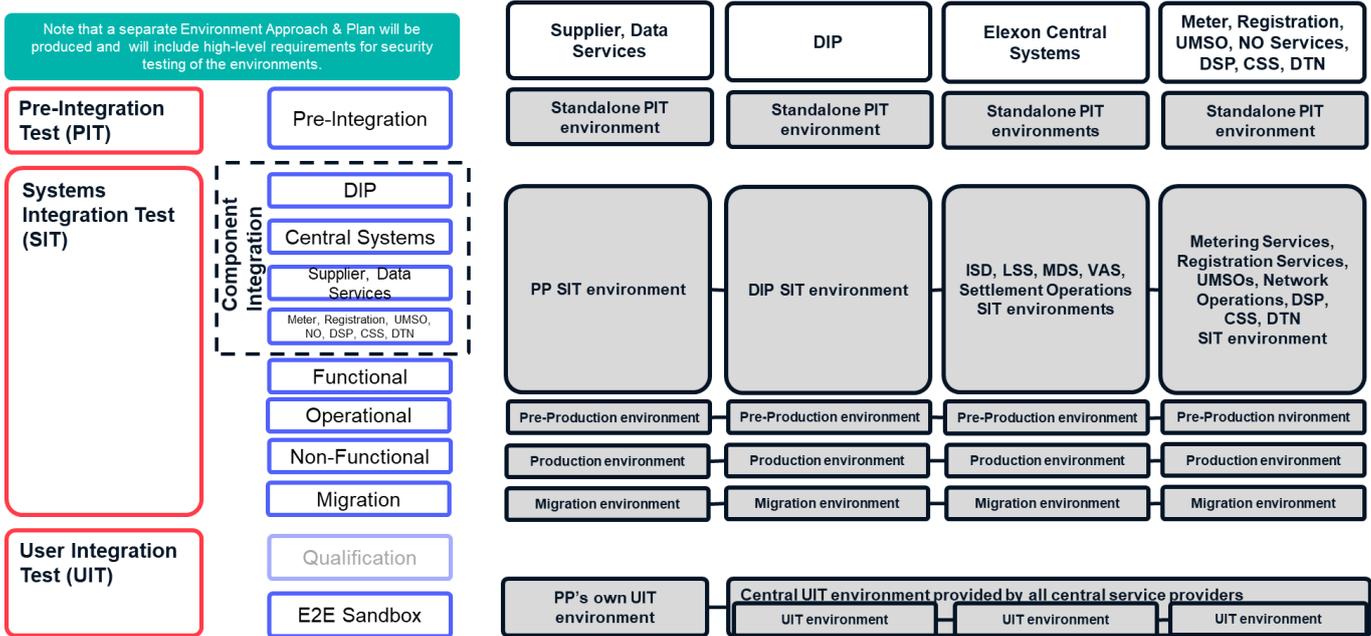


Figure 6 - Test environments for central systems and those non-central PPs participating in SIT

Suppliers and service providers not participating in SIT will need to provide a UIT environment (in addition to whatever they need for PIT). This is shown in Figure 7 - Test environments for PPs not participating in SIT below.

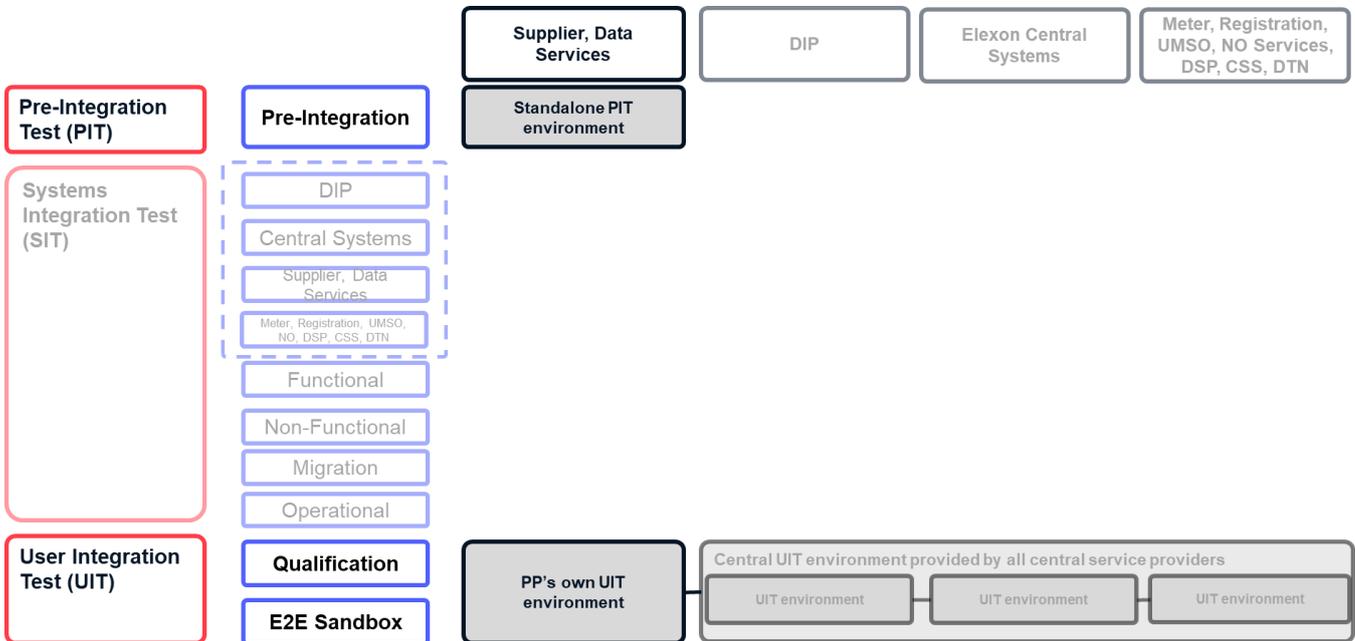


Figure 7 - Test environments for PPs not participating in SIT

## 10 Test Harnesses

### 10.1 Introduction

In this document, the term “test harnesses” means software developed or acquired with the sole purpose of being used in testing the MHHS systems (ie it will not form part of the live system). When carrying out standalone testing (such as in PIT) or when conducting progressive integration of component systems (such as in the Component Integration Testing of SIT) a test harness is often used in the place of one of the “missing” systems. “Test harness” is sometimes termed test stub and does not include tools used for test management (such as ADO or HP ALM).

Test harnesses used in MHHS will be of different types:

- Simulators;
- Data generators; and
- Emulators.

Simulators are typically used to replace a “missing” system in integration and they simulate the behaviour of the missing system, for example by sending/receiving correctly-constructed messages. They can be very simple or can mimic behaviour in a realistic way depending on the requirements. Data generators produce quantities of realistic test data and can be complex. For example in MHHS, consumption data will be generated by such a tool and will have to be realistic, so will have to be designed to generate data that complies with the validation in the Data Services. The data generators will need to be parameterizable and may need to store previous values, for example to ensure coherence of meter readings for a given MPAN. An emulator is sometimes called a “digital twin” and it replicates the behaviour of its target system. The emulators will be used in MHHS to emulate the behaviour of the Data Services in order to work out in an automated way the correct test results.

## 10.2 General principles

For MHHS, where many PPs will require similar test harnesses, the SI team will produce them and make them available to the PPs. This will be more efficient than if each PP produced its own test tooling and will promote standardisation. However, where we recognise that in some areas PPs already have their own test tools and processes, we will not attempt to duplicate these. For example, each PP will typically have its own method of injecting meter readings into its test systems. The way this is done will also differ between PPs and this is therefore not a suitable candidate for an SI team-developed test harness.

The SI team will test the software it develops in a rigorous way, according to our standard Expleo development and quality methodology.

Figure 8 - Test harnesses provided by MHHS IM and Figure 9 - Test harnesses provided by programme participants show the test harnesses expected to be provided by each party.

Phase	Stage	Test harnesses used to support test execution*	Provided by
Pre-Integration Test (PIT)	Pre-Integration	LSS Simulator, MDS Simulator, Consumption Data Generator	MHHS IM
Systems Integration Test (SIT)	DIP	n/a	n/a
	Central Systems	Settlement Period Data Generator	MHHS IM
	Supplier, Data Services	Consumption Data Generator	MHHS IM
	Meter, Registration, UMSO, NO, DSP, CSS, DTN	n/a	n/a
	Functional	SDS Emulator, ARP Emulator, UMSDS Emulator	MHHS IM
	Operational	SDS Emulator, ARP Emulator, UMSDS Emulator	MHHS IM
	Non-Functional	SDS Emulator, ARP Emulator, UMSDS Emulator, NF Settlement Period Data Generator	MHHS IM
	Migration	SDS Emulator, ARP Emulator, UMSDS Emulator	MHHS IM
	Qualification	Consumption Data Generator, SDS Emulator, ARP Emulator, UMSDS Emulator	MHHS IM
User Integration Test (UIT)	E2E Sandbox	Consumption Data Generator, SDS Emulator, ARP Emulator, UMSDS Emulator	MHHS IM

\* test management tool considerations not included

Figure 8 - Test harnesses provided by MHHS IM

Phase	Stage	Test harnesses used to support test execution*	Provided by
Pre-Integration Test (PIT)	Pre-Integration	Consumption data injector	PP
	Systems Integration Test (SIT)	DIP	DIP test harness
Central Systems		DIP test harness	DIP provider
Supplier, Data Services		Consumption data injector	PP
Meter, Registration, UMISO, NO, DSP, CSS, DTN		DSP simulator	DCC
Functional		n/a	n/a
Operational		n/a	n/a
Non-Functional		n/a	n/a
Migration		n/a	n/a
User Integration Test (UIT)	Qualification	Consumption data injector**	PP
	E2E Sandbox	Consumption data injector**	PP

test management tool considerations not included  
 \*\* necessary only if relevant metering service is not available

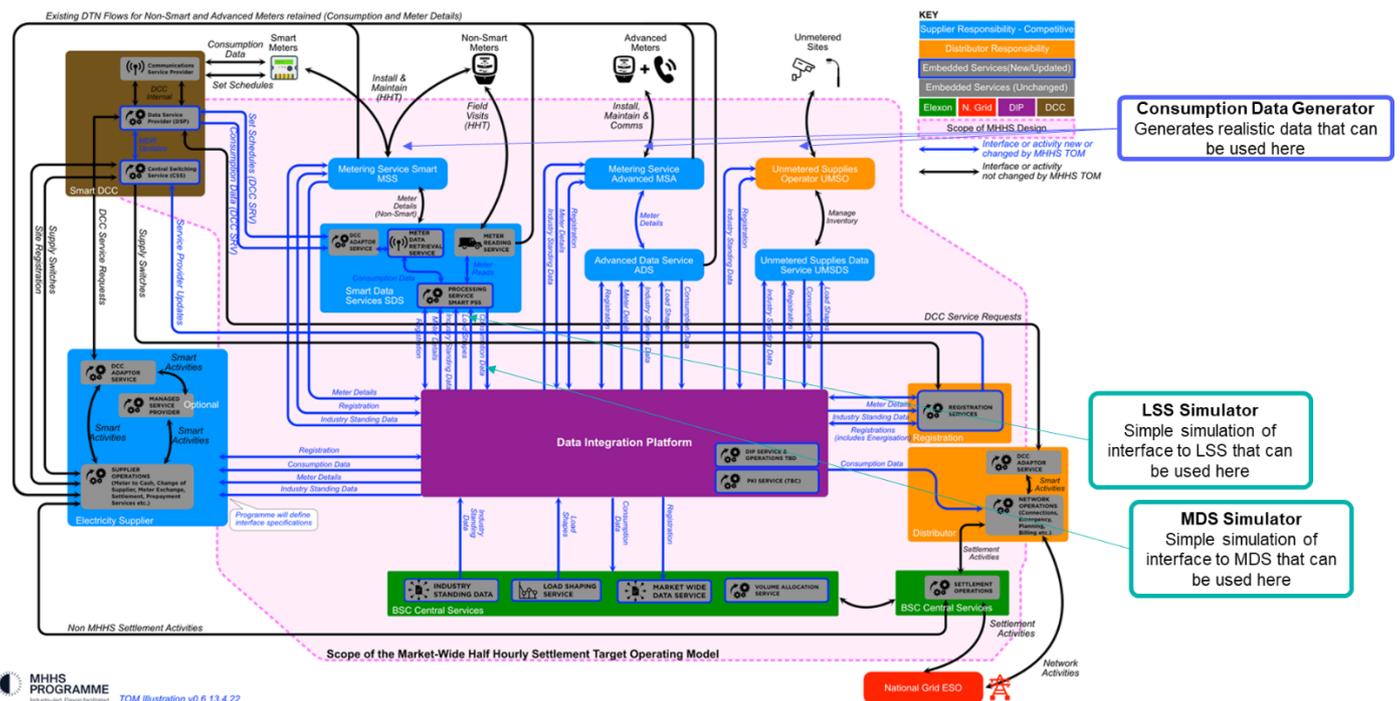
Figure 9 - Test harnesses provided by programme participants

### 10.3 Test Harnesses for Pre-Integration Testing

#### 10.3.1 Introduction

In PIT, each organisation will be testing its own system(s) in a stand-alone manner. The normal approach to this stage in any complex development programme is that each party develops any test harnesses it needs to adequately test its own systems. However, there are some areas where a single centrally-developed test harness will be more efficient overall and will save the PPs time and cost. Where this is the case, a test harness will be developed by the SI team, as described in the following sections.

Figure 10 - PIT test harnesses (below) shows the test harnesses planned to be delivered by the SI team to assist PPs in their conduct of PIT.



### 10.3.2 LSS Simulator

The LSS Simulator will be for standalone PIT use by PPs when they are running tests independently on their own infrastructure. It is intended to be cloud-based (hosted by the SI team) and accessible to all PPs. It will be able to create and receive information in the same way as the real LSS but will have no underlying business functionality (or very little). It is intended to be used in conjunction with the test facilities delivered by the supplier of the DIP solution (the LSS Simulator is not intended in itself to replicate the DIP behaviour).

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### 10.3.3 MDS Simulator

An MDS Simulator will be made available in the same way as the LSS Simulator. Like the LSS Simulator, it will rely on test facilities delivered by the DIP and will have little or not underlying business functionality.

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### 10.3.4 Consumption Data Generator

The Consumption Data Generator will generate test data (suitable for consumption by SDS, ARP & UMSDS). PPs wishing to test their SDS, ARP or UMSDS solutions can use the data generated in conjunction with their own existing test software which will inject the data into their systems under test. The data generated will be realistic, parametrizable and produced in a simple format such as .csv which can be easily imported and used.

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## 10.4 Test harnesses for SIT

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### 10.4.1 Introduction

The reason for using test harnesses in SIT is to replace the “missing systems” as each of the systems in the MHHS landscape is progressively added to the test environment. The first item to be tested is the DIP. Following this, the Elexon Central Systems will be added. In order to exercise these, realistic settlement period data will be needed and the SI team will provide a Settlement Period Data Generator. (Query remaining to be resolved as to whether Project Helix will already be producing something for its own PIT testing which would be suitable for this?)

The Consumption Data Generators produced for PIT will also be used in SIT.

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### 10.4.2 Settlement Period Data Generator

The Settlement Period Data Generator creates test data suitable for consumption by the Elexon Central Systems. It will be configurable for SDS, ARP or UMSDS data provision. Figure 11 - Progressive integration of component systems; test harnesses used, shown below, describes the progressive integration and the harnesses used at each point.

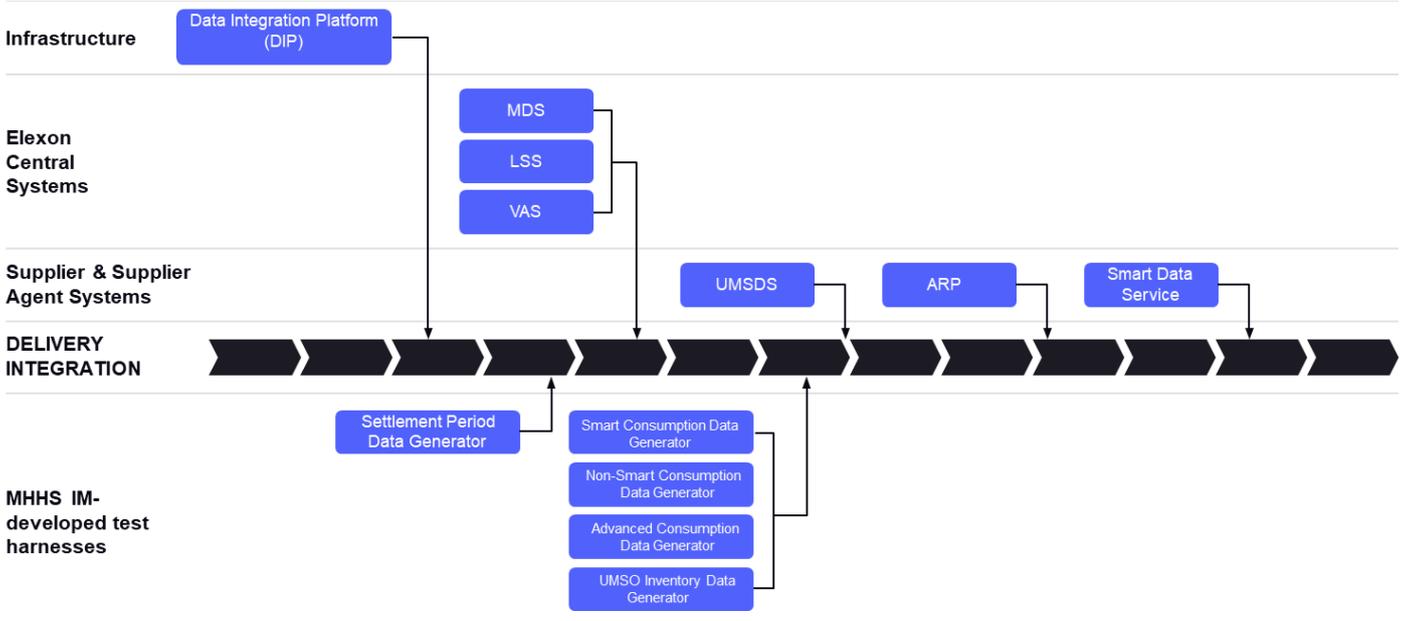


Figure 11 - Progressive integration of component systems; test harnesses used

### 10.4.3 Automated test results generators (emulators)

The SDS Emulator will take as input the test data which enters SDS and produces the result expected from SDS. It will then compare the actual SDS result with the result calculated by the emulator and report on test success or failure. Significant diagnostics will be needed to allow testers to determine the source of the error where the test results do not match. There will also be an ARP Emulator and a UMSDS Emulator. Figure 12 - SDS, ARP & UMSDS Emulators below illustrates this capability.

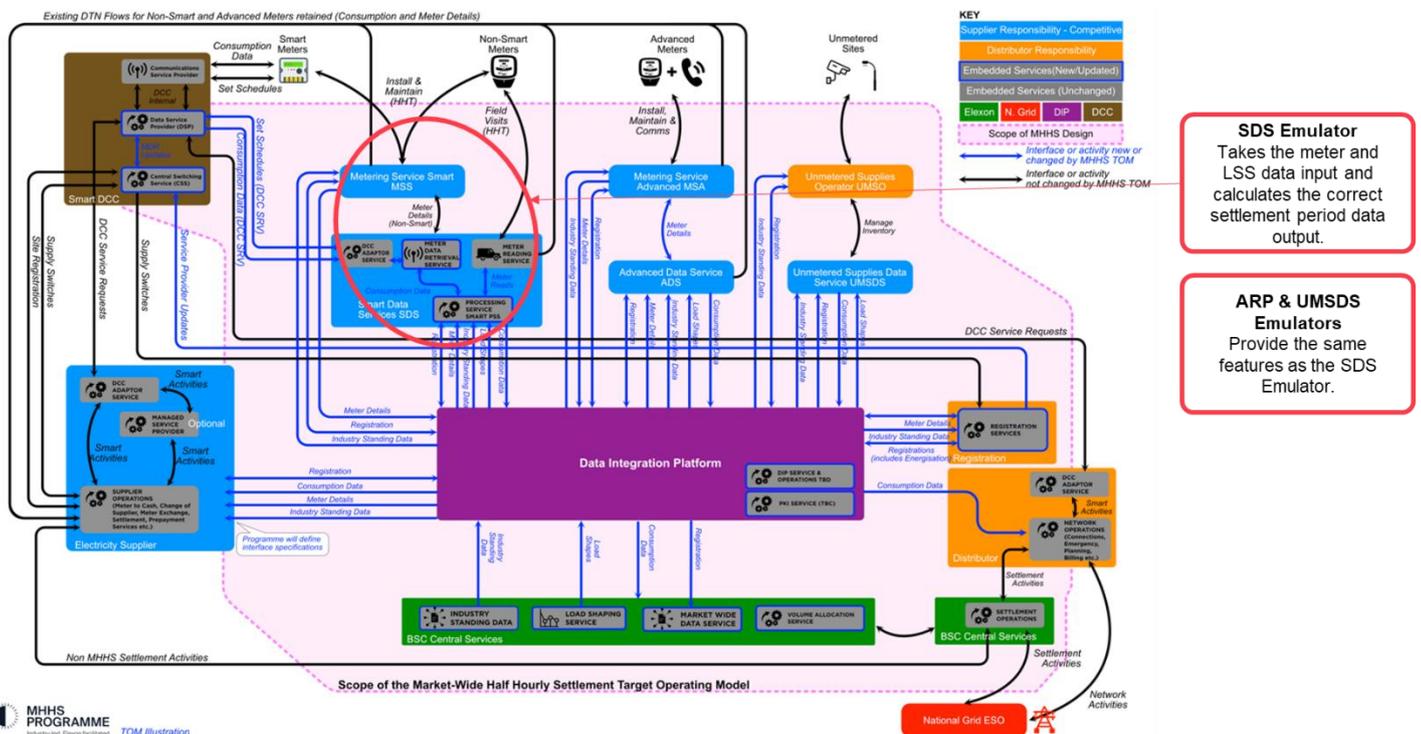


Figure 12 - SDS, ARP & UMSDS Emulators

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## 11 Test Assurance

Test assurance will align with the principles in the IPA Framework defined by the Independent Provider of Assurance (PwC), contracted by Ofgem. It will also be described in detail in the Testing Approach and Plan for each test stage.

The first level of assurance laid down is self-assurance. In line with this, each PP will be expected to assure their own design, build and test. The SI team's own work, in particular test coverage and traceability will be assured by members of the MHHS SRO and QA teams, as well as by testing SMEs from Expleo who are independent of the MHHS programme.

The SI team, with support from the PPC team, will also perform assurance activities with regard to PPs' design and build, readiness for testing, test execution progress and test completion. The SI team may request evidence of the PP's own self-assurance as part of this activity. The SI team will conduct periodic deep-dive assurance on all SIT participants as they move through these activities until the end of PIT and will also assure their preparedness for SIT. Assurance scope will be the full extent of PIT and not just the few tests of the interfaces with the DIP. The assurance will be tailored to each PP's architecture because each one is different and the assurance team will first seek to understand the architecture and then ensure that all changes are being adequately tested. The SI team will conduct similar assurance on a selection of other PPs, ahead of their entry into Qualification. To facilitate the assurance, each PP will be expected to complete a self-assessment to demonstrate readiness ahead of the start of SIT or Qualification. The deep dive assurance will consist of review of some or all of the following:

- PIT Plan;
- Requirements traceability matrix;
- Test scenarios and data; and
- Test completion report (and work-off plan if relevant)
- SIT/Qualification readiness self-assessment.

In SIT, the SI will assure the activities of all SIT participants. There will be periodic deep-dive assurance of each participant, which will inspect the same types of artefacts as the PIT assurance (above). There may also be test witnessing should the SI team feel it appropriate.

The Qualification team will be responsible for assuring the progress and completion of Qualification.

The IPA will provide independent assurance on all of the aspects of preparation for and execution of testing.

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## 12 Defect and Issue Management

### 12.1 Introduction

The issue and defect management approach for the programme will be documented in MHHS Issue & Defect Management Plan and will be used to manage all MHHS programme issues and defects. The MHHS Issue and Defect Management Plan will define the issue and defect management:

- Purpose and scope;
- Process;
- Roles and responsibilities;
- Tool;
- Governance; and
- Reporting.

Participants will be expected to manage their own testing issues and defects in PIT. The MHHS Issue & Defect Management Plan will be used for SIT and UIT. In these phases, the testing issues will be managed by the SI using ADO, where all programme participants will be able to view the status of each issue.

If a testing issue results in a defect being raised, the responsible participant will own and track that defect to resolution at which point the SI will be responsible for coordinating any regression/other testing needed on the SIT or UIT environment. In UIT, in addition to raising defects in programme participants' systems, defects may be raised against the central systems. These central systems defects will be fixed by the responsible party according to SLAs specified in the Testing Approach and Plan for that test stage.

In SIT and UIT, if a defect occurs and it is in a PP's system and has no impact on any other PP's testing nor on the progress of the test stage as a whole, then this defect will be expected to be raised and tracked only in the relevant PP's defect management system. However, for any defect which requires central triage or which impacts another PP or the test stage as a whole, this defect must be recorded in the central system and tracked through to closure centrally.

## 12.2 Defect & issue lifecycle

The diagram in Figure 13 - Defect lifecycle below shows the workflow and decisions associated with capturing a defect and processing it through to resolution, The same process will be used for managing testing issues.

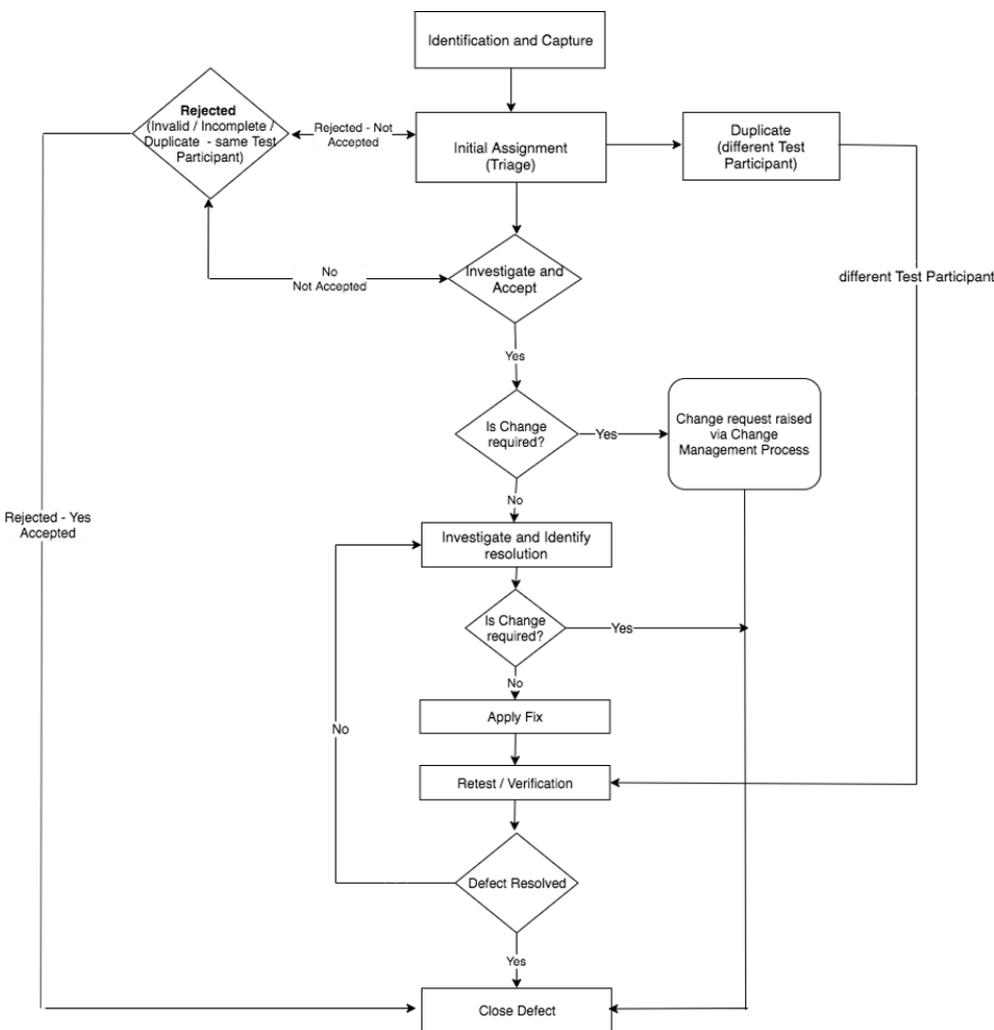


Figure 13 - Defect lifecycle

Note that a defect can also be rejected because all parties agree that it will not be fixed and it is then placed on a register of known issues.

Severity	Description
1	With respect to the relevant party, the issue would: <ul style="list-style-type: none"> <li>prevent user from using their systems</li> </ul>

	<ul style="list-style-type: none"> <li>• have a critical adverse impact on business activities</li> <li>• cause significant financial loss</li> <li>• result in any material loss or corruption of Data.</li> </ul> <p>Non-exhaustive examples are when an issue causes:</p> <ul style="list-style-type: none"> <li>• non-availability of systems</li> <li>• all test progress to be blocked.</li> </ul>
2	<p>With respect to the relevant party, the issue would:</p> <ul style="list-style-type: none"> <li>• have a major (but not critical) adverse impact on use of systems</li> <li>• cause limited financial loss.</li> </ul> <p>Non-exhaustive examples are when an issue causes:</p> <ul style="list-style-type: none"> <li>• non-availability or loss of resilience of a material part of their systems</li> <li>• large areas of functionality to be unable to be tested</li> <li>• testing to be significantly impacted but not completely blocked.</li> </ul>
3	<p>With respect to the relevant party, the issue would:</p> <ul style="list-style-type: none"> <li>• have a major adverse impact on business activities but which can be reduced to a moderate adverse impact through a work-around</li> <li>• have a moderate adverse impact on the business activities.</li> </ul> <p>Non-exhaustive examples are when an issue has:</p> <ul style="list-style-type: none"> <li>• A work-around that will impact test progress although testing is not blocked.</li> </ul>
4	<p>With respect to the relevant party, the issue would:</p> <ul style="list-style-type: none"> <li>• have a minor adverse impact on business activities.</li> </ul> <p>Non-exhaustive examples are when an issue causes:</p> <ul style="list-style-type: none"> <li>• minor service interruptions in the business process.</li> </ul>
5	<p>With respect to the relevant party, the issue would:</p> <ul style="list-style-type: none"> <li>• have minimal impact on business activities.</li> </ul> <p>Non-exhaustive examples are when an issue causes:</p> <ul style="list-style-type: none"> <li>• trivial Issues with work-arounds which are noted for future releases but minimal impact on running existing activities</li> <li>• tests to still pass but there are cosmetic issues.</li> </ul>

Table 6 - Defect severities

## 13 Risks, Assumptions and Dependencies

The following are the major risks which relate to testing:

- **Supplier and service provider participation in SIT** – The ability to perform meaningful E2E testing in SIT relies on the participation of a reasonable number of suppliers and service providers (of Smart Data Services, Advanced Data Services and UMS Data Services) to be able to have a large enough volume of different test cases executed. Without sufficient numbers, test coverage may be inadequate and defects may go undetected and first appear in live operation, where they cause operational and/or business issues. The MHHS programme plans to make SIT participation voluntary for suppliers and service providers and there is consequently a risk that insufficient parties will volunteer. The programme intends to

mitigate this by early dialogue with all parties to determine the best way of ensuring adequate participation.

- **Complexity of migration** – The migration process which will be tested in SIT is complex, with many different stages. It involves “as is” systems operating in conjunction with “to be” systems as the “as is” systems are gradually retired. The testing will be costly because of the number of different systems needed and gaining the buy-in of participants to conducting this may be difficult. The programme intends to mitigate this by early dialogue with all parties to determine the best way of ensuring adequate participation.
- **Complexity of BCDR testing** – Conducting Business Continuity/Disaster Recovery (BCDR) testing across the MHHS ecosystem will be operationally highly complex. It will therefore be prone to error, with the possibility of having to be re-run several times to achieve the goal. This could have a detrimental impact on cost and timescales.
- **Cost of test environments** – Every participant in MHHS will require two or more test environments. Maintaining these environments can be costly, particularly for the central systems (DIP, DSP, CSS, SMRS and Elexon Central Systems). There may be a drive to constrain testing by providing too few environments, resulting again in poor test coverage and defects discovered in live operation. This is particularly true of providing environments large enough to conduct meaningful volume tests. The programme intends to carry out full risk/benefit analyses when assessing the number of environments required to ensure a cost vs testing adequacy balance is obtained.
- **Lack of supplier/service provider engagement in E2E Sandbox testing** – This is a crucial test stage where suppliers and service providers complete proving their systems and business processes. Is it a voluntary stage and it is possible that insufficient numbers of organisations participate. This could cause defects in systems and/or business processes in live running, with consequential operational and/or financial implications. The programme intends to mitigate this by early dialogue with all parties to determine the best way of incentivising participation.

The following assumptions have been made in defining this Testing Strategy:

- **Suppliers’ and service providers’ own test harnesses** – This Strategy assumes that PPs will have their own test harnesses as described in section 10 - Test Harnesses.
- **DSP test harness** – This Strategy assumes that DCC will provide a test harness which will simulate the behaviour of Smart Metering (DSP) to a degree sufficient for the performance of Qualification and E2E Sandbox testing.

As a result of the large number of systems implicated in MHHS, the timely performance of the testing described in this Strategy is dependent on a number of factors which will be closely monitored by the MHHS programme but over which the programme has no direct control:

- **Timely delivery of central systems for SIT** – The timely delivery of the central systems (DCC’s Smart Metering and CSS, the Registration Service (SMRS), the Elexon Central Systems, the DIP and the DTN) in a form ready for SIT is a critical dependency within MHHS.
- **Competing priorities within suppliers and service providers** – MHHS testing is also dependent on the timely delivery of suppliers’ and service providers’ systems for SIT and Qualification. Commercial and other business pressures unrelated to MHHS may cause resource constraints which increase the risk of late MHHS delivery.