STATE OF RHODE ISLAND UNIFIED HEALTH INFRASTRUCTURE PROJECT

CONTINUOUS INTEGRATION REVIEW
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1. EXECUTIVE SUMMARY

The purpose of the Continuous Integration Review is to verify that System Integration Testing (SIT) adequately proved that all aspects of the HealthSourceRI (HSRI) system were functional prior to User Acceptance Testing (UAT). Continuous integration testing, also referred to as SIT, is a high-level software testing process in which testers verify that all related systems maintain data integrity and operate in coordination with other systems/interfaces. The testing process ensures that all subcomponents integrate successfully to provide expected results and the system as a whole performs adequately on the platform in which it is deployed.

According to the Phase 1 Application Development Plan, execution of the SIT Test Plan emphasizes full testing coverage of the functionality and includes the following criteria:

➢ Best practices applied to developing scenarios based on "real-life" situations

➢ Clear scenario success or failure criteria

➢ Measurable entrance and exit criteria established for each test phase

The criteria defined for exiting SIT follows.

➢ Test cases have been executed and passed (or deferred to a future release, if approved by the State).

➢ Severity 1-Critical or Priority 1-Critical defects have been resolved and tested.

➢ Mutually-agreed upon Severity 2-High or Priority 2-High defects, which were not resolved during testing, have been reviewed and deferred by the State. (i.e., The State agreed that it is acceptable to launch with these defects outstanding.) In cases where the State does not agree to defer, these Severity 2-High or Priority 2-High defects should be resolved prior to go-live. The State and Deloitte should collaborate to identify potential quality or schedule risks and then implement appropriate mitigation strategies, if necessary.

➢ The State has validated and signed off on the functionality delivered via the release.

Additional outcomes of the review include the following:

➢ The Test Management Plan does not adequately identify and describe the strategy and approach for all the test phases.

➢ The Detailed Test Plan provides a more in-depth level of detail for testing phases; however, it does not adequately describe the detailed tasks and testing resources required for the different stages of testing.

➢ The Requirements Traceability Matrix (RTM) created by Deloitte does not adequately map test cases back to specific tracks or functional components. As a result, it is difficult to assess the adequacy of the test cases to cover each component without traceability to the RTM.

➢ Section 508 Compliance (Accessibility) testing is not in-depth and should be more thorough within both SIT and Regression.

Although SIT is to verify the application's end-to-end business processes as they connect with external functions, change file and carrier related functions are excluded. CSG recommends appropriate planning with an emphasis on creating more test scenarios/use cases for SIT. This will improve the overall quality of the release delivered into UAT and Production. Additional recommendations are listed in Section 6.

2. INTRODUCTION

2.1   Purpose

This Continuous Integration Review is a thorough review of the detailed SIT plans for Release 6.6 for comprehensiveness, completeness, and traceability. The review includes an assessment of SIT results and also reports observations, issues, and recommendations with practical solutions.

2.2   Review Approach

CSG has conducted the following activities as part of this Continuous Integration Review.

➢ Reviewed the Test Management Plan, Detailed Test Plan, and the Application Development Plan for Phase 1 for comprehensiveness, completeness, and traceability

➢ Verified that test cases were properly mapped through a traceability matrix to requirements, use cases, and other artifacts

➢ Verified the timelines of the testing conducted for each cycle

➢ Reviewed the test plans for all releases to assure that they included plans for both integration and regression testing

➢ Reviewed and assessed the results of SIT activities against the SIT exit criteria and summarized the test results

➢ Reported observations and issues; recommended practical and feasible mitigating solutions

➢ Verified that the HSRI system integration utilizes sound software engineering principles

➢ Reviewed documentation provided by CMS to ensure compliance and readiness for testing where applicable

2.3   Scope

The scope of this document is to provide a review and analysis of the Phase 1 SIT for Release 6.6. The information contained within this report is for the entire PH1 Enhancement Release 6.6 Test Plan in JAMA. The below cycles were created within the Phase 1 Release 6.6 SIT test plan.

➢ SIT

➢ Change File

➢ Carrier Integration

➢ PVC Testing

➢ Accessibility

➢ Regression

➢ Carrier Integration Testing (CIT) Cycle 2

➢ Additional CRs

Within these cycles, testing was executed to cover the following functionality and/or change requests.

➢ Additional SEP Changes

➢ Admin Override Employee SEP

➢ CX Pregnant Woman

➢ Federal PEV

➢ Logic Modification for Medication Termination

➢ SHOP Group XML

The below cycles were included within the Phase 1 Release 6.6 test plan but not executed as part of SIT.

➢ Carrier Integration (CIT) R6.6

➢ Change File (CFT) R6.6

3. SOFTWARE ENGINEERING PRINCIPLES

The objective of SIT is to verify the application's end-to-end business processes as they connect with internal and external functions. SIT confirms that all code modules work as specified and that the system as a whole performs adequately on the platform on which it is deployed. The Institute of Electrical and Electronics Engineers (IEEE) Standard 1012, "IEEE Standard for Software Verification and Validation," June 8, 2005 provides guidance for SIT. IEEE recommends tracing requirements to test procedures and to test results; documenting test execution and results. System Integration Testing Procedures consist of the following:

➢ Creating a system integration test plan

➢ Creating test data

➢ Conducting tests according to the test plan; reporting and reviewing the results of the test

The integration test phase is sometimes combined with the system test phase.

3.1 Systems Integration Test (SIT) Plan

Per IEEE Standards, the Systems Integration Test Plan should adequately plan integration testing to validate that the software correctly implements the software requirements and design as each software component is incrementally integrated with each other. The SIT Plan should include the following.

➢ The tracing of requirements to test design, cases, procedures, and results;

➢ Test tasks and expected results; and

➢ Compliance with project defined test document purpose, format, and content.

Section 4.1 of this document includes the review of Deloitte's Test Management Plan for Systems Integration Testing. At a high-level, the SIT Plan was created in accordance with IEEE standards. The Plan includes testing of component, test tasks, and it provides a link to the JAMA tool housing requirements; however, the Test Plan fails to address test resource requirements and traceability.

3.2 Test Cases

IEEE Standards for developing test cases for integration testing suggest that test cases comply with the project's defined test document purpose, format, and content. The test cases should satisfy the requirements included in the test plan for each component. The SIT test cases as written do not provide a level of detail to determine the level of compliance with the IEEE Standards.

The RTM, as currently provided, does not clearly list the requirements by business/system function. No relationship between the requirement and the functional component (track) can be derived from the RTM. This mapping is critical to building effective test cases. In addition, the format chosen for the RTM does not allow for review and analysis of traceability. As a result, the SIT test (cases) activity does not comply with IEEE standards.

3.3 Test Plan Execution and Reporting

IEEE Standards recommend that test results are analyzed to verify that software components are integrated correctly and satisfy system requirements. Test results should trace to test criteria established by the test traceability documents; results are to be documented as required by the Test

Plan. Test acceptance criteria need to be met and discrepancies between actual and expected test results are to be documented.

The SIT Test Plan, execution, and reporting for Release 6.6 did not fully comply with IEEE standards for the following reason.

➢ Due to requirements and use cases being inconsistently populated within JAMA, traceability is difficult to ascertain.

4. CONTINUOUS INTEGRATION REVIEW

4.1 Test Plan Review

4.1.1 Test Management Plan

The purpose of the Test Management Plan is to describe the overall strategy and approach for unit, system, regression, integration, performance, stress/load, and user acceptance testing for the Unified Health Infrastructure Project (UHIP). The Plan accomplishes these items by including a high-level overview of each test stage, including test policies and processes to support the various test stages.

The objectives of the Test Management Plan ensure the following:

➢ Changes do not adversely affect previously verified functional components

➢ Individual components of a system function correctly when passing data, information, and screen control

➢ The system interfaces with other systems, including external third-party systems, in a production-like environment

➢ New builds to an environment are ready (or not ready) for further testing

➢ User needs, requirements, and business processes are conducted to determine whether a system satisfies the acceptance criteria; they also enable the user, customers, or other authorized entities to determine whether to accept the system

➢ Application performance metrics are evaluated to determine if they meet agreed upon Service Level Agreements (SLAs) for the project

4.1.2 Detailed Test Plan

The Detailed Test Plan provided by Deloitte describes the strategy and approach for implementing and executing the Test Management Plan (Plan 06). It outlines the scope of the overall testing effort, the types of testing required, the test team organization, the estimated effort needed to plan and execute, and the roles/responsibilities of the team involved. The Detailed Test Plan for Phase 1 identifies the types of testing and the approach; it also addresses the approach to the following key requirements.

➢ Specific Roles and Responsibilities

➢ Test Scenario and Test Case Writing

➢ Test Planning and Preparation

➢ Entrance/Exit criteria

The Detailed Test Plan fails to account for the following requirement as described in the Deliverable Expectation Document (DED).

➢ Test Resources

  ✓ The absence of test resources in the Plan raises questions about the planning associated with task work effort and duration.

  ✓ In addition, scheduling in the plan did not take into account defect testing in SIT and the re-execution of test scripts.

4.1.3 Regression Testing

According to the Test Management Plan, regression testing may be performed within each test phase (after completing the planned test cases and before the exit criteria review). Included in the Test Management Plan and the Detailed Test Plan is the approach to regression testing. Deloitte utilizes multiple test cycles in JAMA and smoke testing to conduct regression testing throughout the various iterations.

The Test Management Plan states that the testing team will attempt to automate regression testing where possible using the Selenium automation tool; however, this tool has yet to be used in any testing.

The details contained in this report support the conclusion that the level of regression testing was insufficient due to the number of defects identified and deferred in UAT.

4.2 SIT Case Review

Test cases in JAMA seem to align with the level of information provided in the use cases, which is at a very high level and not all FDDs contained use cases. While most test cases appear to have been mapped to a requirement, none were mapped the use cases documented.

The below scenarios prompted test case failures and defects to be logged in UAT and ultimately deferred; it raises the question of the level and quality of testing executed. These issues have been identified as existing production behavior and/or requirement not defined.

➢ Account with <100% FPL is conditionally eligible for APTC

➢ Incorrect MAGI eligibility and enrollment for change reporting

➢ Change File doesn't update with Incarceration "Y" field

The table below displays the number of SIT test cases in JAMA by cycle for the Release 6.6 test plan.

Table 1 - Test Cases by Cycle

Test Cycle	Test Cases Executed	Total Cases Executed Passed without Errors
Accessibility	11	11
Change File	19	19
Carrier Integration	45	45
CIT Cycle 2	26	26
PVC Testing	6	6
Regression	98	98
Additional CRs	68	66
SIT	490	490
Total	**763**	**761**

4.3   Verification of Test Case Mapping

According to Plan 04 Application Requirements Review, the RTM should provide the ability for the team to view how each requirement is addressed in downstream work products. The Requirements Traceability Matrix (RTM) maintained by Deloitte does not provide a detailed list of test cases with bi-directional traceability to requirements, use cases, and defects. JAMA Contour is established as the RTM software tool to document requirements and associated elements such as designs, requirements, and use cases to create bi-directional traceability; however, there is minimal traceability in JAMA.

The bullets below address deficiencies within the RTM that prevent traceability.

➢ Deloitte maintains an Excel spreadsheet for traceability that lacks the information to provide full traceability; it is unclear as to how the RTM is maintained

➢ The RTM, as currently provided, does not demonstrate whether or not the requirement has been met

➢ Test cases for Release 6.6 were not mapped to use cases; this mapping is critical to building and providing insight into what is being tested and creating scenarios/test cases

➢ The RTM does not track test plans or test results; nor does it accurately reflect the requirements associated within Release 6.6

➢ Although use cases were documented in some of the functional design documents, there is no evidence of the use cases being entered in JAMA (i.e., the requirement traceability tool)

4.4   Review of Timelines

The following table specifies the scheduled start and end dates for Release 6.6 SIT as well as the actual start and end dates.

Table 2 - SIT Schedule

Phase 1	Scheduled Start Date	Scheduled End Date	Actual Start Date	Actual End Date
February 2016 Release 6.6 – SIT	11/04/2015	12/18/2015	11/04/2015	12/30/2015
February 2016 Release 6.6 – CFT/CIT	12/28/2015	01/22/2016	12/30/2015	01/26/2016

4.5   Release 6.6 SIT Test Cycles

The SIT test cycles were executed for the following purposes.

➢ Testing functionality that was required and necessitated by a change request

➢ Retesting cases that failed previously

➢ Testing individual cases that were included for regression purposes

➢ Testing Federal compliance for Section 508 (Accessibility)

4.6   Review of SIT Results

Our review of SIT results indicates that the exit criteria was met for Release 6.6 prior to production.

The exit criteria, as defined by the Detailed Test Plan, along with the status are displayed in the table below. Deloitte's SIT Exit Report is the only means of confirming the fourth requirement.

Table 3 - SIT Exit Criteria Results

#	Item/Objective	Status
1	Mutually-agreed test cases have been executed and passed (or deferred to a future release, if approved by project leadership)	Met
2	Mutually-agreed Severity 1-Critical or Priority 1-Critical defects resolved and tested	Met
3	Mutually-agreed Severity 2-High or Priority 2-High defects which were not resolved during testing have been reviewed and deferred by the UHIP Leadership Team (i.e., the Leadership Team has agreed that it is acceptable to begin UAT with defects outstanding)	Met
4	UHIP functionality delivered for Release 6.6 has been validated and the Deloitte Test Team has signed off on this functionality	Met

At the start of UAT, one (1) defect remained open; however, the State agreed to exit SIT. The following table provides a summary of SIT defects that were open at the start of UAT. This defect was fixed and closed the third week of UAT.

Table 4 - Open SIT Defects at Start of UAT

Key	Summary	Severity	Status	Resolution
UHIP-107624	MAGI other income - Incorrect error message when old record is end dated and new record is added	Medium	Open	

4.7   SIT Root Cause Analysis

An analysis of JIRA defects reveals a list of root causes as determined by Deloitte that are common across all SIT cycles.

➤ Coding Incorrect/Coding Not Done/Code Inefficient

➤ Environment Issue

➤ Functional Specification

➤ Invalid Defect

Coding related issues made up 39% of the total defects logged. While this is not uncommon in SIT, it should be at a minimum in UAT. The below table identifies the root cause by severity.

Table 5 – SIT Root Cause Analysis

Root Cause	Severity 1-Critical	Severity 2-High	Severity 3-Medium	Severity 4-Low	Total	Percentage
Coding Incorrect	2	41	30	0	73	**23%**
Environment Issue	15	13	7	0	35	**11%**
Functional Specification	1	21	12	0	34	**11%**
Code Inefficient	0	18	14	1	33	**11%**
Invalid Defect	1	20	10	0	31	**10%**
Test Error	1	10	6	0	17	**5%**
Not Reproducible	0	10	6	0	16	**5%**
Coding Not Done	0	10	5	0	15	**5%**
Data Migration	0	11	2	0	13	**4%**
Code Merge	2	2	8	0	12	**4%**
Duplicate	0	6	4	0	10	**3%**
Unable to Determine	0	4	2	0	6	**2%**
Configuration Issue	1	2	2	0	5	**2%**
Technical Design / Data Model	0	3	0	0	3	**1%**
Limitation of Technology or Tools	0	1	1	0	2	**1%**
Change Request	0	0	0	1	1	**0%**
Query Inefficient	0	1	0	0	1	**0%**
Requirement Not Defined	0	1	0	0	1	**0%**
None Identified	0	0	4	0	4	**1%**
Total	**23**	**174**	**113**	**2**	**312**	**100%**

4.8   Carrier Integration Testing (CIT)

Two (2) cycles of testing were executed for CIT. Cycle 1 consisted of 45 test scenarios, and Cycle 2 consisted of 26 test scenarios. The test scenarios appeared to be validation scripts; however, attached to each test case was a file containing test scenarios/transactions, XML, and EDI files. Validation of the XML and EDI transactions occurred outside of JAMA. A total of 24 defects were logged (1 critical, 5 high, and 18 medium) outside of JAMA.

4.9   Change File Testing (CFT)

The high level test cases loaded in JAMA were used to execute the test scenarios for the functionality being tested in the Change File. Each scenario contained an Excel spreadsheet documented the day-to-day transactions and expected results. The 19 scenarios loaded tested Federal PEV, CX Pregnant Woman, and Regression; all cases were passed. A total of 10 defects were logged (6 critical, 3 high, and 1 medium) outside of JAMA. There is no way to link the defect back to the corresponding test case.

Note: Carrier Integration and Change File testing are executed on a separate schedule from SIT.

4.10   CIT/CFT Root Cause Analysis

An analysis of JIRA defects reveals a list of root causes as determined by Deloitte that are common across the CIT/CFT cycles.

➢ Environment Issue

➢ Coding Incorrect

Environment related issues made up 38% of the total defects logged. While this is not uncommon in SIT, it should be at a minimum in UAT. The below table identifies the root cause by severity.

Table 6 – CIT/CFT Root Cause Analysis

Root Cause	Severity 1-Critical	Severity 2-High	Severity 3-Medium	Severity 4-Low	Total	Percentage
Environment Issue	5	1	7	0	13	**38%**
Coding Incorrect	0	2	3	0	5	**15%**
Invalid Defect	1	1	2	0	4	**12%**
Test Error	1	2	1	0	4	**12%**
Data Migration	0	1	2	0	3	**9%**
Code Inefficient	0	0	1	0	1	**3%**
Code Merge	0	0	1	0	1	**3%**
Coding Not Done	0	0	1	0	1	**3%**
Configuration Issue	0	1	0	0	1	**3%**
Duplicate	0	0	1	0	1	**3%**
Total	**7**	**8**	**19**	**0**	**34**	**100%**

5. FEDERAL COMPLIANCE TESTING

CMS requires various functionality and services to be tested and implemented to ensure compliance and consistency. Testing includes Accessibility testing for new functionality that is being implemented.

5.1   Section 508 Accessibility

Deloitte executed 11 test cases related to Section 508 Compliance testing (Accessibility) using the JAWS, Total Validator, and WAVE tool application. Deloitte's letter of attestation, indicating the successful execution and completion of Section 508 Compliance, is attached below.

RI UHIP - Release 6 6
- Section 508 Complia

6. ISSUES AND RECOMMENDATIONS

This section summarizes the issues identified during the Continuous Integration Review and includes recommendations.

Issue #1: Planning

➢ The Detailed Test Plan had multiple planning deficiencies.

  ✓ The testing schedule did not address the need for multiple testing cycles to fix and test defects.

  ✓ The test plan did not adequately address the impact of delays in functionality that did not pass SIT testing during the pre-determined schedule.

  ✓ The SIT test scenarios were not reviewed with appropriate stakeholders for consistency, applicability, and determination of directional accuracy.

  ✓ Results of defect resolution were not reviewed or confirmed by the State.

➢ Requirements were uploaded and/or inputted without the information needed to allow the mapping of specific requirements to a specific release or functional area. This does not allow JAMA, the testing tool, to provide sufficient requirement or use case traceability.

➢ Carrier Integration and Change File are executed outside of SIT and are not included as part of the SIT schedule.

Recommendations

➢ Update the Test Plan to include a schedule with multiple testing cycles within each appropriate testing phase and include defect testing activities. The Plan should specify detailed resource requirements for each test activity; including test case creation, test execution, and code remediation.

➢ Test cases should be uploaded with all the necessary fields populated to facilitate effective reporting and mapping.

➢ Update JAMA to reflect the most current requirements and validate that existing traceability remains accurate.

➢ Based on lessons learned from prior SIT activities and the analysis of SIT planning for previous iterations, the State should continue to increase its participation in SIT planning and execution.

➢ As indicated in the Detailed Test Plan, time should be allowed for review and sign-off on the test scenarios; review the SIT scenarios with appropriate stakeholders for consistency, applicability, and to determine if they are directionally accurate.

➢ Conduct a SIT exit meeting to review the status of issues encountered and any remaining open defects regardless of severity/priority.

➢ Continue to utilize the Collaborative Meeting to review SIT testing efforts and defects logged.

Issue #2: Quality

SIT quality can be assessed based on the following scenarios.

➢ There were a number of test cases executed in under a minute.

➢ Test cases marked 'pass with error' does not show the test case being addressed after the defect fix.

➢ The inability to determine whether all the test cases provide adequate coverage may provide a false level of confidence to stakeholders.

➢ Use cases should be entered into JAMA and mapped accordingly.

➢ Deloitte does not code or test for complex scenarios.

Recommendations

➢ Revise the project schedule to allow for the following.

   ✓ An adequate review and feedback of design documents

   ✓ Conducting a technical review or demo of the application

   ✓ Updates to the solution based on feedback

➢ Once defects have been fixed, the failed test steps in JAMA should be re-executed to ensure that the fix actually worked; JAMA should be updated to reflect the results of this testing.

➢ Scenarios and/or use cases identified by the State SME should be included within all functional design documents; this will allow the State to recognize and agree on what is being tested in SIT and provide feedback.

➢ It is highly recommended that Deloitte utilize automated regression testing; this could increase the coverage and minimize defects going in to UAT.

Issue #3: Communication/Engagement

Although great improvement was seen in this area, the following issues remain

➢ The communication between Deloitte and the State is lacking during SIT (i.e., the State has limited input). Test cases and scenarios are defined by Deloitte in most cases.

➢ It is not clear whether all issues identified during SIT are communicated to the State (i.e., medium and low defects).

➢ There is a lack of full transparency in SIT progress and development.

➢ Defect(s) appear to be identified as being addressed in Problem Management without State approval (e.g., UHIP-107704).

Recommendations

➢ Review and discuss the SIT cases/scenarios to identify areas that are in need of additional testing.

➢ The State should provide a list of real-life scenarios to be tested.

➢ This list of "defects" should continue to be presented as part of the SIT exit meeting.

➢ Deloitte should provide a weekly analysis of SIT results; this includes level of coverage, functionality tested, and defects logged.

➢ Defects that are moved out of SIT into another 'Production' area should have State approval and documentation supporting such move attached to the defect.