Transaction Security

D2.1 Master Test Plan

ETC

636126

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Version	Date	Changes
0.2	2016-01-23	Added risk section. Added objective Section Added stakeholder Minor additions to the section on Test Approach and Test Techniques
0.3	2016-04-01	Revised and Updated
0.4	2016-04-07	Updates after review from OTI and meeting with TLS
0.5	2016-05-19	Input from Pilot Partners Review from OTI
0.6	2016-06-09	Finalized the architecture from TLS. Improved the readability.

List of Acronyms

Acronyms	
E2E	End to End
ETC	European Travelers Club
GST	Generic Secure Token
JCGP	Java Card with Global Platform
MTP	Master Test Plan
OEM	Original Equipment Manufacturer
OTI	Open Ticketing Institute
PTO	Public Transport Operator
SPV	Special Purpose Vehicle
STAS	Secure Token Acceptance Sensors
SUT	System under test
TLS	Trans Link Systems
UAT	User Acceptance Testing

Management Summary

This document describes the Master Test Plan (MTP) for the European Travellers Club (ETC) project. The ETC is a European funded Horizon 2020 project under the grant agreement No. 636126. It communicates the test planning among the stakeholders.

In this document the overall test plan is described with input from all the work packages. It includes also:
- as close to real world simulation of Pilot ABT use cases as possible via Travel Scheme test environments with emulation of segments that are not available.
- User Panels to refine user experience, before Pilot launch.
- The different test cases, used in the end-to-end testing between the pilot systems and the interoperable hub.
- All tests for testing of transactions between token and terminal and between terminal and central authentication and routing hub.
- All test cases for testing the Interoperable Account System with the central authentication and routing hub.
- The test entry and exit criteria and the criteria for evaluating the pilots.

Table of Contents

List of Tables

List of Figures

1 Project description

1.1 Project name

European Travellers Club (ETC). Project number 636126.

Deliverable 2.1, Master Test Plan.

1.2 Project Goal

The Open Ticketing Institute (OTI) has successfully applied for funding from the European Union as part of the Horizon 2020 Transport Program and has been awarded a grant for the project “The European Travellers Club: Account-Based Travelling across the European Union”.

The project started on 1st of May 2015 and will last 24 months. The European Travellers Club (ETC) is a program by and for European transport ticketing schemes or operators, travellers’ organizations and technology providers to create seamless account-cased traveling across the European Union. As part of this project, OTI has developed specification for an ETC system and also funded reference implementations of the primary components of the ETC system. In addition to the reference implementation funded by OTI, third party vendors in the transit ticketing industry have committed to develop prototype implementations of selected ETC system components.

UL, as part of the consortium, is responsible for the Quality Assurance (WP 2) in the project [3]. The Master Test Plan (MTP) is a formal deliverable as part of agreed deliverables.
UL’s agreement is to provide testing services in order to confirm the reference and third party implementations of ETC components and systems. The test service being provided include:

- Test management
- Test specification
- Test code and script development
- Test execution, reporting and results analysis

1.3 Objective of the Master Test Plan (MTP)

The objective of the Master Test Plan (MTP) is to inform all who are involved in the test process about the approach, the activities, including the mutual relations and dependencies, and the (end) products to be delivered for the ETC project.

The master test plan describes the test approach, the activities and (end) products that need further elaboration in the other system test plans. These system test plans need to be abstracted from this master test plan.

1.4 Scope

The following system elements are in scope:

- Smart cards with Generic Secure Token
- Secure Token Acceptance Sensors (STAS)
- Hub

- Non GST Terminal Functionality
- Specific service module:
    - Luxembourg parking service
    - Luxembourg ‘click’ service
    - German ticket stock service

1.4.1 Generic Secure Token

The Generic Secure Token (GST) is an application which executes on a medium that the customer carries and presents to validation terminals when making use of public transport and other related services. The GST is currently specified for Java Card with Global Platform (JCGP). As a result, the GST testing is limited to testing the single reference implementation of the GST on JCGP. There is only one implementation of the GST which is the reference implementation.

1.4.2 Secure Token Acceptance Sensor

The Secure Token Acceptance Sensor (STAS) specifies functionality to be included in validation terminals to enable them to support ETC for travel. As such, it is not intended as a comprehensive terminal specification. The STAS specification covers the following areas:

- Generic terminal behaviour
- Commands and responses between STAS and GST
- Commands and responses between STAS and Hub

In addition to the one OTI reference implementation of STAS, there are {number of terminals to test} prototype implementations from transit ticketing equipment vendors.

Testing is limited to terminal functionality covered by the STAS specification for all the terminals listed above.

1.4.3 Hub and Services

The Hub is a back-office system, to which all terminals that implement the STAS functionality need to connect. The Hub primarily performs transaction authentication and routing functions in the system. Specialised sub-systems connect to the ETC system through the interfacing to the Hub. There is a single implementation of the Hub (i.e. the reference implementation of OTI). In order to perform lab testing of the hub, before services have been developed, stub implementations of the following service could be used:

- Payment Stubs
- Customer Interface Stubs
- Service Stubs

Initial testing is limited to the reference implementation of the Hub. Some test scenarios would require the service stubs to be connected to the Hub (e.g. for end-to-end system tests). In such scenarios, the service stubs themselves are not in scope for testing as they are not actual pilot implementations. From the perspective of testing, the sub-system stubs could be considered part of the test harness and therefore not part of the system under test (SUT). When the actual services for the various pilot become available, they will be introduced into the test environment, and therefore included in the SUT.

The Hub has a revised role in the Dutch Pilot. This is further described in Section 7.3.

1.4.4 Non GST Terminal Functionality

Certain terminal functionality apart from the GST will also be tested as part of the pilot setup. For example, VDV testing for the German pilot will be done at appropriate phases. However, it must be noted that these testing activities cannot be done by UL, as the non-GST system requirements are specific to each scheme participating in the pilot. They will be carried out at the behest of the pilot specific members and is under ETC's test scope.

2 Test organization

2.1 Introduction

This chapter provides general information about the test organization. It describes the organizational setup, the tasks and responsibilities, the meeting structure and the reporting agreements.

2.2 Organizational setup

- **Project Coordinator**
  - Open Ticketing Institute (OTI), responsible for European Travel Lab and central systems [4].
  - Will perform tests according to the Master Test Plan in the European Travel Lab.
  - Will implement the central systems: ETC Ecospace, which will be connected to the systems of TLS, Verkéiersverbond, AVV (and/or their suppliers).

- **Test Organization**
  - UL Transaction Security; UL TS BV

- **Consortium Partners [6]**
  - Communauté des Transports (Verkéiersverbond)
  - NXP SEMICONDUCTORS AUSTRIA GMBH
  - Open Ticketing Institute (OTI)
  - TRANS LINK SYSTEMS BV
  - UL TS BV
  - VDV eTicket Service GmbH & Co KG

- **Pilot Specific Involvement [4]**
  - Dutch Pilot
    - TLS, responsible for delivering the work package.
    - Arriva, PTO facilitating the live pilot.
    - Pro Data/Kapsch, supplier of validators which read the GST.
  - German Pilot
    - VDV-ETS, partner in the consortium. It has delegated the execution of the pilot to AVV.
    - AVV, responsible for delivering the pilot.
    - ASEAG, PTO facilitating the live pilot.
    - IVU Traffic Technologies AG, supplier of validators which read the GST.
  - Luxembourg Pilot
    - Verkéiersverbond, responsible for delivering the pilot.
    - Scheidt & Bachmann is the supplier of the access gates and parking terminals in the Belval parking area.
    - CFL, is the PTO and operates the Belval parking area.
    - INIT, supplier of validators which will be used for click service terminals.
    - OTI, supplier of the application which makes it possible to check the number of clicks and OTI is also supplier of click service.

2.3 Tasks and responsibilities

Name	Function/Role	Tasks and responsibilities
Udit Anand	Test lead Tester	Develop MTP Coordinate test activities Develop E2E test cases Execute E2E tests and report
Menno deBell	Test lead Tester	Coordinate test activities Develop component test cases and automated test code Execute component tests and report
Ciaran Brennan	Tester	Develop component test cases and automated test code Execute component tests and report
Christian Brafine	Test Project manager (UL)	Coordinate and manage project activities and customer engagement
Eric Coetzee	Test lead (overview)	Oversee development of MTP and E2E test cases
Rogier Boogaard	Transit domain expert	General oversight and advise on testing

Table 1: UL's Roles and Responsibilities

2.4 Agreements on reporting

Component testing is performed on a given component when a new software / hardware version is released. After a component test cycle, the test results are recorded in a report and submitted to OTI.

An E2E test cycle is performed at agreed times during the system development process. For E2E testing, test reports are generated each time a test cycle is performed. Each test cycle is followed by a test report which is submitted to OTI.

System defects recorded during E2E testing, is recorded in a defect tracking system, operated by 42Tech, to which UL test team have access.

A bi-weekly project review meeting is held between UL and OTI, during which test progress update is reported and recorded.

3 Planning of activities

Refer [1] for the planned activities for this project and other related information such as amount of effort required.

4 Test base

4.1 Introduction

This MTP is developed based on the contents of the documents listed in the following table.

4.2 Documents

Document name	Version	Status	Remarks
2016-03-17 MTP status meeting notes	1.0		
20160113_AVV_electronic fare management-strategy-postmeeting			WP 12 German Pilot
20160324_Project Plan Pilots	0.1		
20160506_Project Plan Pilots_v_0 92	0.92		
API specifications			
draft pilot plan Lux	2.0		
e-2-e Lab Test.pptx	0.2		
ETC_AVV_ASEAG-1			German Pilot Plan
ETC_CA_H2020 version 2.0 final 02042015	2.0		
Generic Secure Token Personalisation on GP Compliant Platforms	2.1.5		
Generic Secure Token Personalisation Requirements	2.1.3		
Generic Secure Token v2.1.1 Release Notes	2.1.1		
GST AIDs	1.3		
Grant Agreement-636126-ETC-4			
H2020 Test Overview_29.01.2016			
HL test approach.pptx	0.6		
Hub Design			
Interface Specification Document (STAS) v1.0 FINAL	1.0		
Interoperability Hub			
OTI Generic Secure Token Application Specification 2.1	4.2.4		
STAS behaviour and interface specification	1.0		
Technical Action Points 22march16			WP 11 Dutch Pilot
Test Suite			Document describing the functional test suite.
Verkéiersverbond P+R Interface Specification PMS	0.97		WP 13 Luxembourg Pilot

Table 2: MTP Base Documents

5 Pilot Dependencies and Risk Analysis

5.1 Pilot Dependencies

	Dutch Pilot	Luxembourg Pilot	German Pilot
Dutch		None	✓
Luxembourg	None		None
German	✓	None	

Table 3: Inter-pilot dependencies

5.1.1 Dutch Pilot Dependencies

1. The Dutch scheme needs to be able to bill German tickets to their clients;
2. Contactless cards with the generic ETC token need to be distributed to Dutch travellers;
3. The Dutch partner will need to recruit and communicate with participants who will travel in the German pilot environment;
4. The Dutch partner will need to provide the token ID's of the participants.
5. The Dutch partner will need to inform participants with information on travels within the German region (for instance through a mobile app).

5.1.2 German Pilot Dependencies

1. Germany needs to contract travellers in such a way that 'pay-as-you-go' fares as used by the Dutch scheme can be billed and paid.
2. Contactless cards with German transit application (VDV-KA) and a generic ETC token need to be distributed to German travellers;
3. The German partner will need to recruit and communicate with German participants who will travel in the Dutch pilot environment;
4. The German partner will need to provide the token ID's of the participants;
5. The German partner will need to inform participants with information on travels within the Dutch region (for instance through a mobile app).

5.1.3 Luxembourg Pilot Dependencies

1. No dependencies.

5.2 Risks

The Risks have been grouped into two categories: General and Specific. The General category risks refer to the document **[1]** and covers the risks associated with the project on the whole. The specific category risks cover risks related to specific pilots.

5.2.1 General Risks

Risk Category	Risk Area	Risk Mitigation Measure
Scope is not effectively controlled	The program includes not only the development of technical standards, but also their implementation and maintenance. Therefore, the scope of the program needs to involve a governance structure and essential central services needed for technical interoperability and institutional trust between the actors in the field.	Set Up ETC as franchise organization for standards and central services.
Tight Planning	Ambitious planning and need to manage the project. This means there is little slack in the planning.	We mitigate this risk by strict program management, and –if absolutely necessary- the willingness of consortium partners to work over a longer period of time (three years instead of two).
Tight Planning	Many actors not involved. Because of the need to deliver in time, we have chosen a relatively small consortium, meaning that there is now an additional task to reach out to all relevant actors in the field.	Reach out to other actors through Ambassadors, ETC, Science Forum, Vendor Forum, industry Organizations.
Tight Planning	Minimum deliverables to start interoperable ABT are delivered in time. This is reflected in the relatively tight planning of the program and the choices with regard to the depth of development now for certain elements. As per Grant Agreement-636126-ETC-4, the current package is sufficient to start interoperable ABT, whereas the structure itself is designed for continuous development and improvement.	
Adequate Support and Uptake	Support from travelers (Organizations). The program gathers the support of travelers and their organizations. Therefore we have given a high priority to demonstrating a superior travel experience in the Lab and full support for traveler-in-control privacy, as well as a strong role for travelers (or their representatives) in the governance structure.	Make travelers part of governance structure. Create superior travel experience and traveler-in control privacy.

Adequate Support and Uptake	Support from transport authorities, e-ticketing schemes and transport operators.	Use e-TSAP framework to involve major schemes. Deliver value. Lower Interoperability costs. Involve schemes.
Adequate Support and Uptake	Acceptance from commercial suppliers and service providers.	Set Up ETC with limited not-for-profit scope. Create open ecosystem with open standards.
Dependency	Dependency on small SPV for all central components. Because of the need to deliver integrated standards and systems in time and to retain the expertise needed to further develop and maintain these standards over time in a non-commercial entity, we have chosen to form a special-purpose-vehicle as soon as possible (using OTI to set up the European Travelers Club as a not for-profit foundation).	Involve all partners in ETC/Lab. Assign project admin to VDV and Quality Assurance to UL.
Dependency across Multiple Environments	Multiple pilot environments. Because of the need to explore, develop and demonstrate interoperability between independent schemes in Member States, we have included three pilots managed by each scheme. This means that more operational environments need to be managed	Keep national schemes in charge of pilots. Use Travel Lab to support pilots.
Dependency across Multiple Environments	Pilots dependent on central integration in Lab. Because of the need to ensure standards across Member States, and therefore across pilots, we have chosen to first develop, implement and test use cases in the Travel Lab before testing them in pilots. This creates planning dependencies.	Tight program management, but if necessary delays are accepted.

Table 4: General Risks

5.2.2 Dutch Pilot Risks

Risk Category	Risk Area	Risk Mitigation Measure
Inadequate design documentation	The demand side information is limited. As such, the test harnesses and test specifications are becoming the reference against which the system is to be measured. This introduces a risk that the tests might have gaps which go undetected, as there is no reference for the specification.	
Multiple interpretation of specifications	The design specifications are misunderstood between the implementers	

Non exhaustive specification	Insufficient coverage of design specifications example cross border ticket error	
System Failure	Fund settlement fails	
Connection with external interfaces to perform testing	Changes in test harness to test scenario where hub simulator is replaced by an external system Connection with TLS Hub could pose challenges.	
Regression Testing	Testing impact of GST on PTO's system to make sure there is no interference of systems or loss of functionality of current systems.	
Interdependency with other pilot partners	The Dutch pilot and the German pilot are intertwined and for a large part dependent on each other.	Plan regular in depth meetings to discuss relevant topics on interfaces between pilots. During the testing and LAB phase the functioning can be technical tested without dependencies of the German partner (using a Dutch card with GST through the Back office of Translink towards OTI HUB). Be prepared to internally decouple activities that support the Dutch pilot from activities for the local pilot to avoid unnecessary dependencies.
Infrastructure Interdependency	The Dutch pilot is highly dependent on the IDBT-back office project of Translink. The back office is mandatory for the Horizon 2020 project. Critical resources are needed for both projects.	Project team will manage dependencies actively and timeline of both project are aligned within the adjusted planning.
Lack of clarity in specifications	Specification and pilot design will leave interpretation to the consortium partners.	Specification and pilot design will leave interpretation to the consortium partners.

Table 5: Dutch Pilot Risks

5.2.3 German Pilot Risks

Risk Category	Risk Area	Risk Mitigation Measure
First roll out of e-ticketing scheme	There is no e-ticketing scheme in place in the AVV area yet. Due to this fact it is difficult to describe expected risks for the German pilot. It was agreed on detailing this document section as we proceed.	
Regression Testing	Testing impact of GST on PTO's system to make sure there is no interference of systems or loss of functionality of current systems.	
Infrastructure requirements are not met in time.	Validators are not delivered in time. The Dutch pilot and the German pilot are intertwined and for a large part dependent on each other.	Contract supplier in time: deploy first validators on cross-border lines and then on lines which are most likely to be used by Dutch travellers.
	Specs leave too much room for interpretation: suppliers make wrong choices. The Dutch pilot and the German pilot are intertwined and for a large part dependent on each other.	Engage in a joint process with OTI and suppliers to monitor and guide implementation.
Interdependency with Dutch Pilot	The Dutch pilot and the German pilot are intertwined and for a large part dependent on each other.	Plan regular in depth meetings to discuss relevant topics on interfaces between pilots. During the testing and LAB phase the functioning can be technical tested without dependencies of the Dutch partner. Be prepared to internally decouple activities that support the Dutch pilot from activities for the local pilot to avoid unnecessary dependencies.

Table 6: German Pilot Risks

5.2.4 Luxembourg Pilot Risks

Risk Category	Risk Area	Risk Mitigation Measure
Insufficient time for testing.	System is not functioning properly when starting the pilot.	Allow sufficient time for testing in the travel lab.
Tight Planning	Planning is too tight for good field tests.	Start with a core of friendly users first (employees of CFL for example).
Dependency on infrastructure components	Certain components are not delivered in time	Accept a pilot setting which is gradually scaled up during use.
Highly Critical	A lot of components are on the critical path.	Have project management meetings in which progress for each of the components is discussed: make go-no go decisions for the roll out of certain components. Have back-up plans ready in case one of the components delays.

Table 7: Luxembourg Pilot Risks

6 Objectives and Acceptance criteria

Overall Objective: To demonstrate Account-Based Travelling for both regional and cross-border travellers on the basis of Pay-As-You-Go and Post payment propositions.

6.1 Dutch Pilot

Objective: To demonstrate that holders of a German account can travel (= pay for trips and get real-time personal feedback on their journey) with a Dutch PTO on cross border bus lines and on the regional bus lines, by using their 'home account'. Payment is based on direct fare calculation.

Sub Objectives	Acceptance Criteria
Acceptance of the accounts of German travellers by a Dutch PTO/scheme.	Achieved when German-owned GST's are accepted by Dutch PTO/scheme.
Acceptance by a Dutch PTO or Trans Link Systems of a method to pay for trips made in the Netherlands through the German scheme	Achieved when there is agreement with VDV-ETS / AVV on how bills are settled and who takes risk on non-paying travellers.
The inspection of the right to travel in the account of travellers by a Dutch PTO.	Achieved when inspectors can establish a correct check-in for a trip or constructing an on-board (higher) check-in fee in the back office.
The calculation of fares by the Trans Link Systems back office for Account Based Ticketing travellers.	Achieved when fares are calculated and are aligned with the OV-chipcard price sheet.
The invoicing of fares by Trans Link Systems to a German PTO or VDV-ETS	Achieved when each trip results in an invoice.

Table 8: Dutch Pilot Objectives

Dutch Sub Objectives to support German Pilot

Dutch sub-objectives to support German pilot	Acceptance Criteria
Enabling Dutch pilot participants to buy tickets for services from a German PTO.	Achieved when the purchase of tickets is possible for Dutch participants.
The issuance of contactless cards with a Dutch transit application (OV-chipcard) and a generic ETC token.	Achieved when it is proven in the lab that this is possible*.

Table 9: Dutch Pilot Objectives to support German Pilot

* In an early project phase the issuance of OV-chipcard with a generic ETC token was identified as risk due to limitations of the standard from a governance perspective. It was therefore decided to test the technical feasibility in the lab.

6.2 German Pilot

Objective: To demonstrate that holders of a TLS account can travel on the basis of a ticket and can receive personal journey information with a German PTO, by using their 'home account'.

Sub Objectives	Acceptance Criteria
Acceptance of the accounts of Dutch travellers by a German PTO (or authority).	Achieved when Dutch-owned GST's are accepted by German PTO/scheme.
Enabling Dutch pilot participants to buy tickets to make trips served by a German PTO	Achieved when Dutch travellers can make trips and travel rights are given in the form of a ticket.

The inclusion of on-line created tickets in the account of travellers	Achieved when tickets are linked to the ID's of Dutch travellers.
Signing-up German travellers on a payment method accepted for pay-as-you-go fares in the Netherlands	Achieved when contracts can be signed with customers which enable pay-as-you go.
The issuance of contactless cards with German transit application (VDV-KA) and a generic ETC token.	Achieved when two systems are delivered on one card.

Table 10: German Pilot Objectives

6.3 Luxembourg Pilot

Objective: To demonstrate the possibility of integrating services for public transportation and parking by applying the back-office functions of Account-Based Travelling.

Sub Objectives	Acceptance Criteria
Demonstrate the multi functionality of the Luxembourg-transit card (mKaart), by issuing mKaart's (equipped with VDV-KA) with a GST.	
Demonstrate that public transportation services and parking can be combined and offered in such a way that users experience the services as an integrated product.	
Study whether the attractiveness of public transportation for travellers increases when travellers receive a discount on parking when using PT.	

Table 11: Luxembourg Pilot Objectives

6.4 Non Transaction Flows

Acceptance of pre-pilot systems for pilot deployment will also depend on other (non-transaction flow) systems and processes, these flows will also require testing. The testing for these systems and processes will be done by the parties responsible for their respective pilots. For example, TLS will conduct tests for non-transaction flows pertaining to the Dutch Pilot.

A non-exhaustive list of the flows is mentioned below:

1. Reconciliation, settlement and invoicing processes and systems
2. Customer service processes and system
3. Access management system (to onboard customers)
4. Configuration management

7 Test strategy

7.1 Testing Phases and Scope

7.1.1 Testing Phases

- **Component Testing Phase:** Development of automated tests for GST (card) and STAS (terminal).
    - GST test suite will be used to test cards with GST as the cards become available.
    - STAS test suite will be used to test each Original Equipment Manufacturer (OEM) terminal as they become available.

- **Integration Testing (formerly E2E Lab Testing Phase and Integration Testing Phase)**: Will verify the reference implementations of GST, STAS and Hub. Manual tests will be conducted in Amersfoort on a Lab environment. These tests might be performed on a reference implementation that would mimic the actual implementation.

- **Pre-pilot Lab Testing Phase:** Intended to verify each region's specific configuration using pilot hardware/software. This will be same as Integration Testing Phase but will use scheme specific components:
    - OEM STAS specific to scheme.
    - Different flavours of GST (home and visitor).
    - Users will be invited to test the use cases in the Lab.

  Several iterations are expected with possible OEM fixes to STAS and GST.

- **Pre-pilot Regression Testing Phase:** Intended to verify existing functionality of terminals and cards using pilot hardware/software. **Out of scope for UL/OTI.**

- **Pilot Deployment Testing Phase:** Intended to verify pilot production deployments before issuing cards to pilot users. In field testing by doing subset of E2E test cases. These will be executed each tome the pilot is extended.

Testing Phases	Responsible Party
Component Testing Phase	UL
Integration Testing Phase	UL
Pre-Pilot Lab Testing Phase	UL
Pre-Pilot Regression Testing Phase	PTOs / PTAs
Pilot Deployment Testing Phase	PTOs / PTAs

Table 12: Testing Phases and Responsible Party

Note:

1. In the Integration testing phase some level of E2E testing might also be performed by third parties.
2. There might also be some level of integration tests on certain components of the systems by PTOs.

7.1.2 Test Levels

The following Test Levels are in scope with respect to the above described system elements:

- Unit Testing
- Integration Testing
- Pre-Pilot Testing
- Acceptance Testing

Test level	Techniques / Comments
Unit tests	Unit tests are performed by organisations that development software and hardware for the project. As each organisation have their own unit test approach, the details are not recorded in all cases.
Integration tests	The following integration tests are to be performed: • Card component tests: Integration of GST with existing card applications. • Dutch, German and Luxembourg pilot scheme cards with GST application regression tests to be performed as part of component tests. • Terminal component tests: Integration of STAS functionality with existing terminal software. • Lab E2E tests: Integration of Hub, reference terminals and GST.
Pre-Pilot tests	Pre-pilot E2E test of a full system which consists of: • Hub • OEM terminals which implement STAS • Dutch, German and Luxembourg pilot scheme cards with GST application • Pilot services integrated to the Hub • Any other third party system which is to form part of pilot.
Acceptance tests	The following acceptance tests are to be performed: • User Acceptance Test (UAT) of the full pre-pilot system implementation, which marks OTI's acceptance of the pre-pilot. • UAT of each production pilot deployment, which marks OTI's and pilot partners' acceptance of the deployed pilot systems.

Table 13: Test Level and Corresponding goals

Testing Levels	Responsible Party
Unit Testing	42Tech,
Integration Testing	UL
Pre –Pilot Testing	UL
Acceptance Testing	PTO/PTA's

Table 14: Testing Levels and Responsible Party

7.2 Test approach

7.2.1 Overall Testing Approach

- The Luxembourg pilot is given priority because of the imminent deadline.

7.2.2 Component Testing Phase

- An automated test harness for testing the card and terminal is being developed. Figure 1 and 2 show the card test harness and terminal test harness implementations.
- The single card implementation of GST will be tested using this test harness.
- All card configurations will be tested using the test harness.
- Regression tests on Dutch, German and Luxembourg pilot scheme cards with GST application.
- Cards manufactured by external parties will be tested using the card test harness.
- Reference terminal and terminals developed by suppliers will be tested using the terminal test harness
- To support the TLS terminal testing, the test harness will connect to an external system. This is further described in Section 7.3.2
- A host of test cases are developed to verify the implementation.
- A subset of these test cases will be used to verify each pilot implementation.
- The subsets will be grouped into test suites. Each suite will have a name and description of where it applies.
- One such test suite will be regarding performance tests.
- One such test suite will be regarding endurance tests.

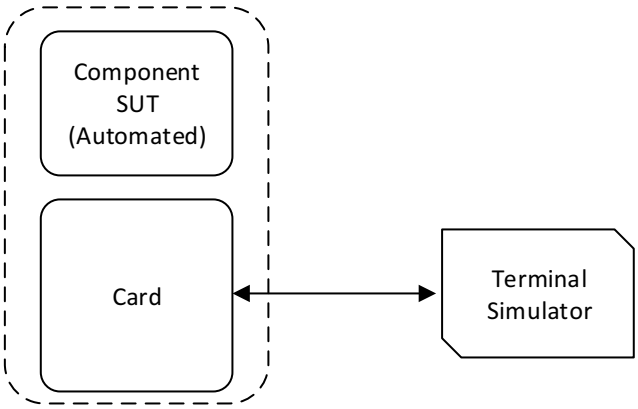

Figure 1: Card Test Harness for Component Testing

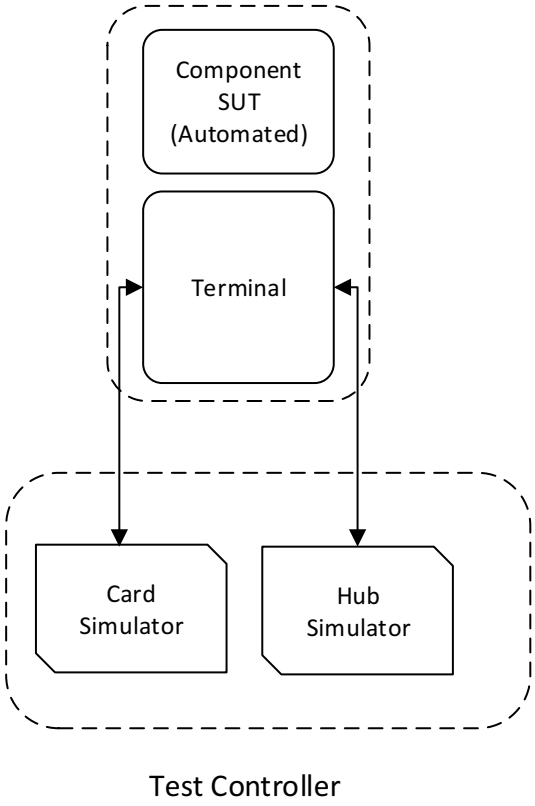

Figure 2: Terminal Test Harness for Component Testing

7.2.3 Integration Testing Phase

- Integration test specification tailored for the pilot project configuration
- The Integration tests will first be used to verify a lab implementation of the system
- With each implementation of a new terminal, a subset of the Integration tests will be executed on a lab setup which includes the new terminal.
- The Integration tests are intended to verify reference implementations of GST, Hub and STAS.
- Manual tests will be conducted in Amersfoort. Several iterations are expected.
- Each Pilot deployment will be verified using a subset of the Integration test cases
- These test subsets will be grouped using test suites. Each suite will have a name and description of where it applies. Tests could belong to multiple suites.

Note: *The demand side information is limited. As such, the test harnesses and test specifications are becoming the reference against which the system is to be measured. This introduces a risk that the tests might have gaps which go undetected, as there is no reference for the specification.*

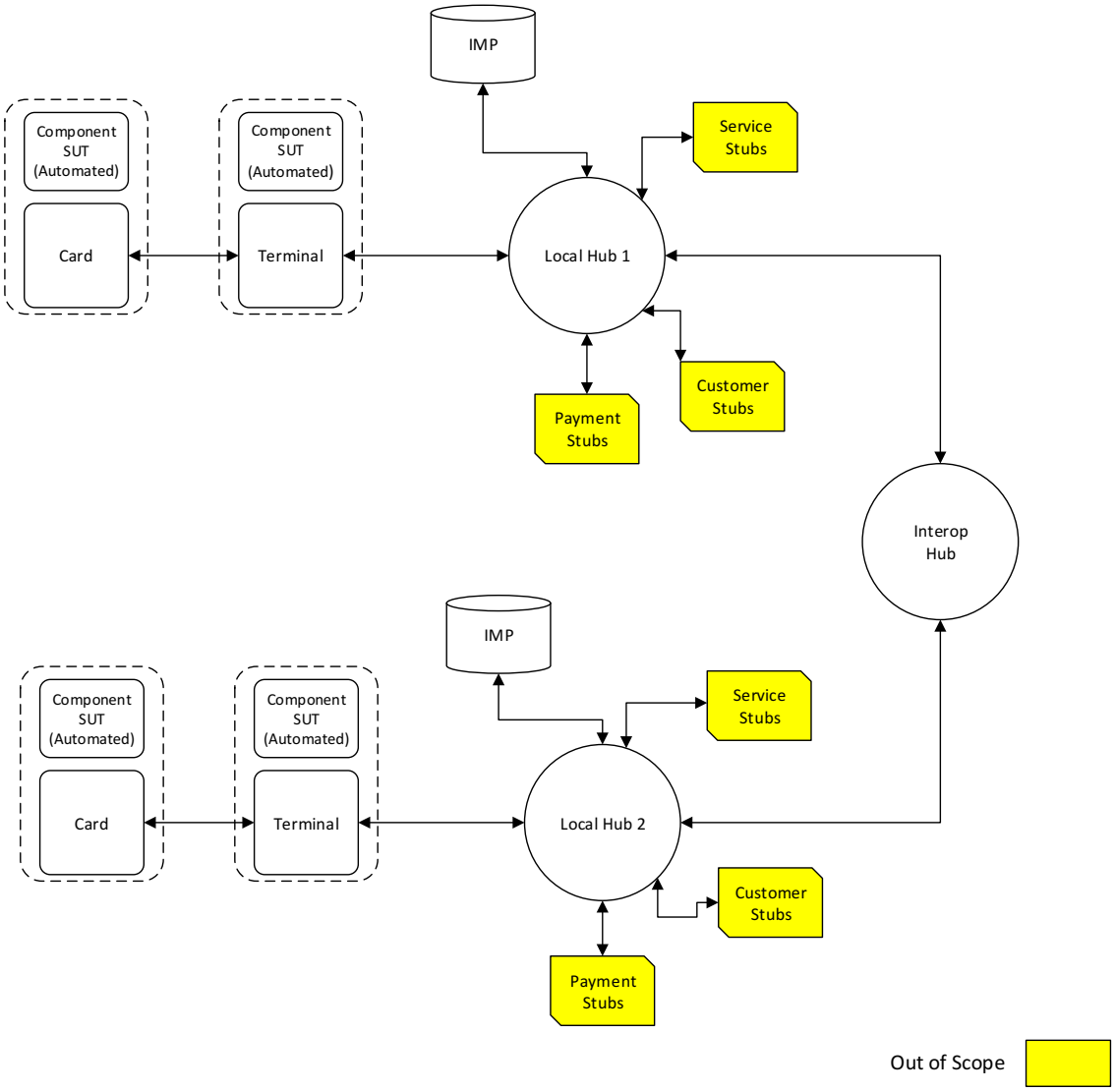

Figure 3: Scope of Integration (E2E) tests

7.2.4 Pre-Pilot Lab Testing Phase

Pre-pilot testing of a full system will consists of:

- Hub
- OEM terminals which implement STAS
- Dutch, German and Luxembourg pilot scheme cards with GST application
- Pilot services integrated to the Hub
- Any other third party system which is to form part of pilot.
- Users will be invited to test the use cases in the Lab

The testing will be performed in two steps:

1. **Step1:** Entire pilot lab setup will be tested, including the Hub, OEM terminals, the pilot specific cards and any other third party system exclusive to the pilot. The connection between the local hub and the interop will be simulated. This to reduce the dependency on the other pilot. Figure 4 shows the scope of Step 1.

2. **Step2**: Entire pilot lab setup will be tested, including the Hub, OEM terminals, the pilot specific cards and any other third party system exclusive to the pilot. The connection between the local hub and the interop is no longer simulated. Figure 5 shows the scope of Step 2.

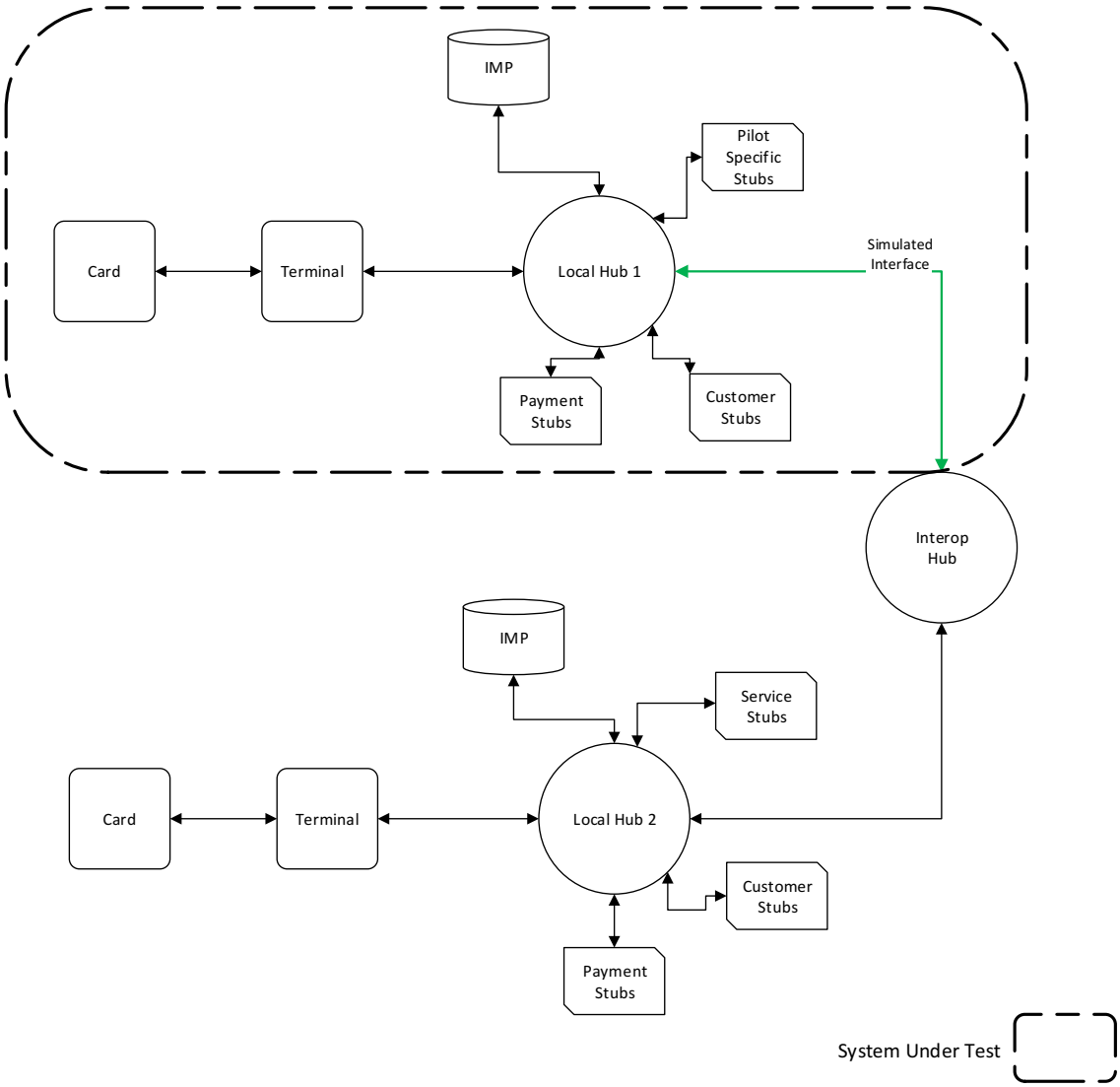

Figure 4: Step 1, Pre-Pilot Lab Testing

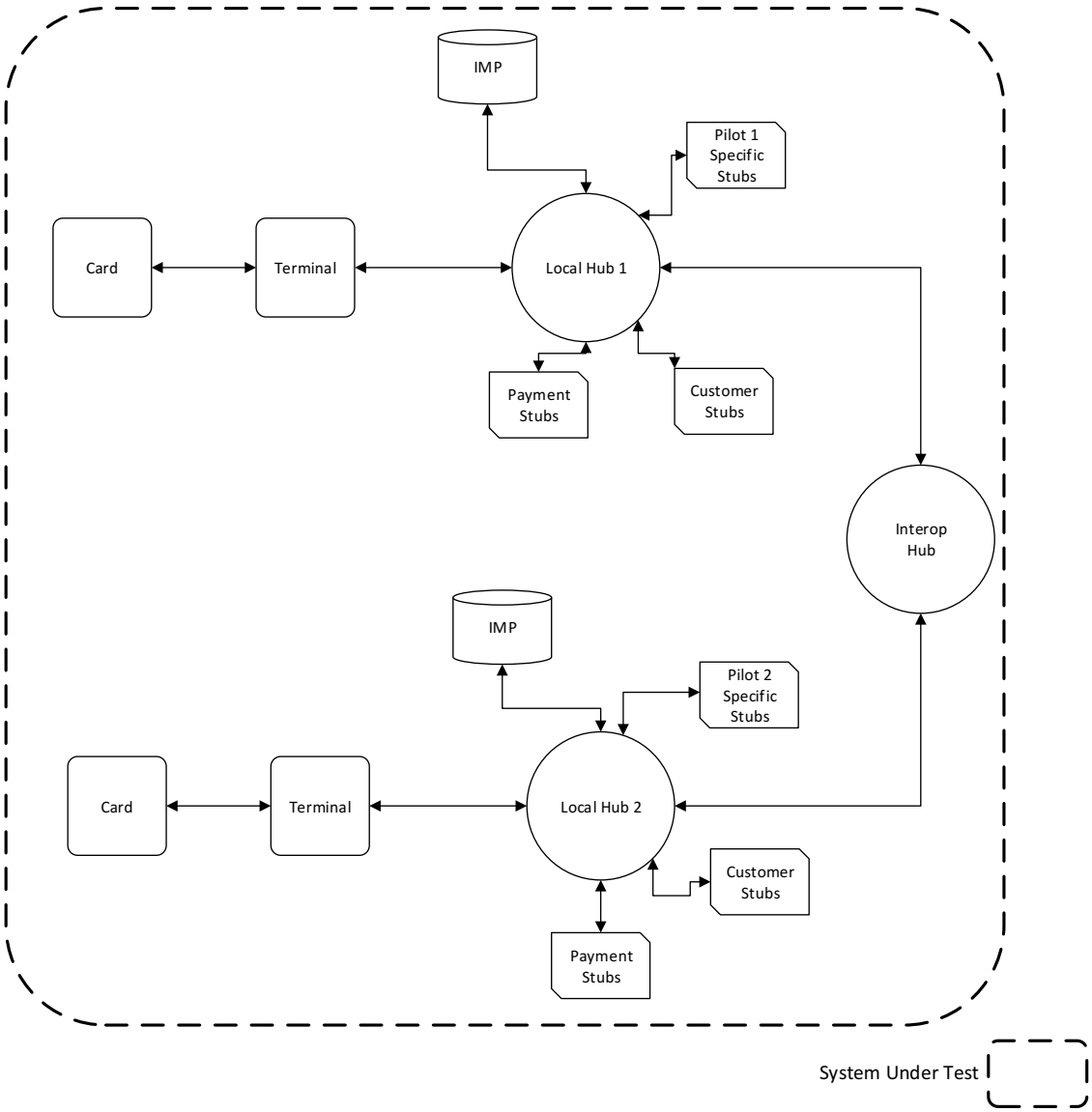

Figure 5: Step 2, Pre-Pilot Lab Testing

7.3 Test Approach: Dutch Pilot

7.3.1 Dutch Pilot Architecture

The Dutch Pilot architecture deviates from the general architecture described in Section 7.2.3 and represented in Figure 3. In the general architecture the hub is a back-office system, to which all terminals that implement the STAS functionality need to connect. The Hub primarily performs transaction authentication and routing functions in the system. Specialised sub-systems connect to the ETC system through the interfacing to the Hub. In the Dutch pilot, the TLS local ETC hub is mainly used to get access to the interoperable hub. In other words, it would have no services (not even stubs) and no IMP. Instead of an IMP, the customer information is in the normal TLS back office system where customer data is stored. The Dutch pilot architecture is shown in Figure 6.

Furthermore, the Dutch pilot introduces the Local Support System (LSS). The LSS is a component that would be placed between the Dutch Validators and the TLS central back office. Its main application would be to act an interface between transaction on the terminal and the TLS back office, validate a tap in/tap out on the terminal and send the corresponding transactions to the TLS back office. As an example, consider LSS as a group of 3-4 validators on the bus. When a travellers gets on the bus the traveller taps in on the validator correspondingly when the traveller gets off the bus the travellers taps the validator again. The LSS will validate the tap in – tap out and communicate the journey transaction information to the TLS back office.

Note: The exact specification of LSS is still in progress there could be the one master validator as opposed to a group of validators. Also, there is a possibility that there might not be a LSS in which case the validators would communicate directly with the TLS Back office.

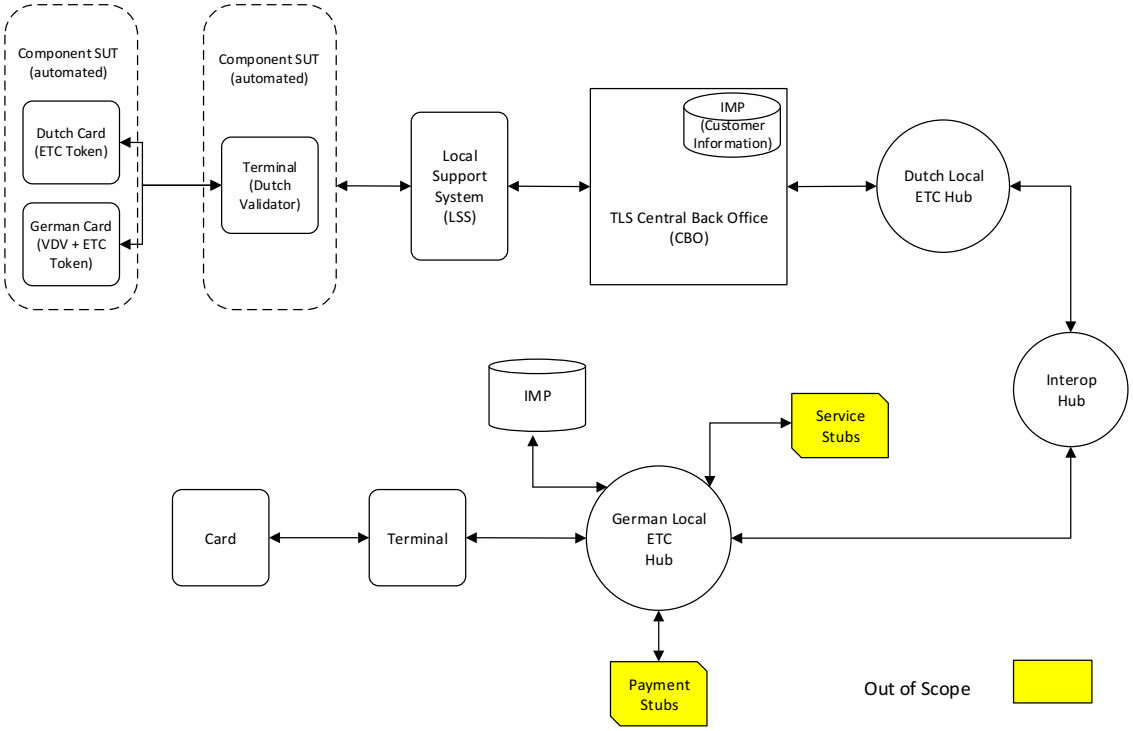

Figure 6: Dutch Pilot Architecture

Note: *The Dutch Pilot Architecture represented in Figure 6 will be replaced by the official architecture when provided by TLS. The architecture above captures the core components and has been approved in a meeting held on May 31, 2016 between TLS, OTI and UL.*

7.3.2 Component Testing

As an effect of the change in architecture, there is an impact on the setup for performing the Component testing specifically STAS (terminal) testing. To accommodate the deviation, it has been decided that the TLS terminals in the ETC lab will connect to a TLS back-end system at TLS offices, which in turn will connect back to the service stubs in the ETC lab. The change in design is represented in Figure 7.

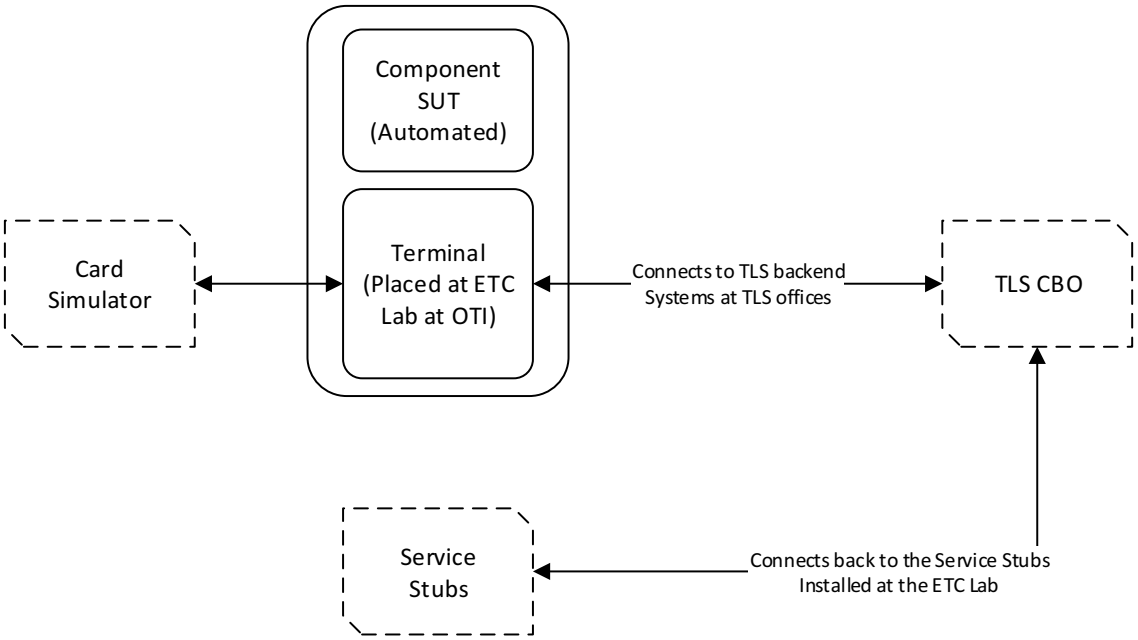

Figure 7: Terminal Test Harness for Dutch Pilot.

7.3.3 Integration and Pre – Pilot Testing

In line with the architecture described in Section 7.3.1. The Scope of System Tests is represented in Figure 8.

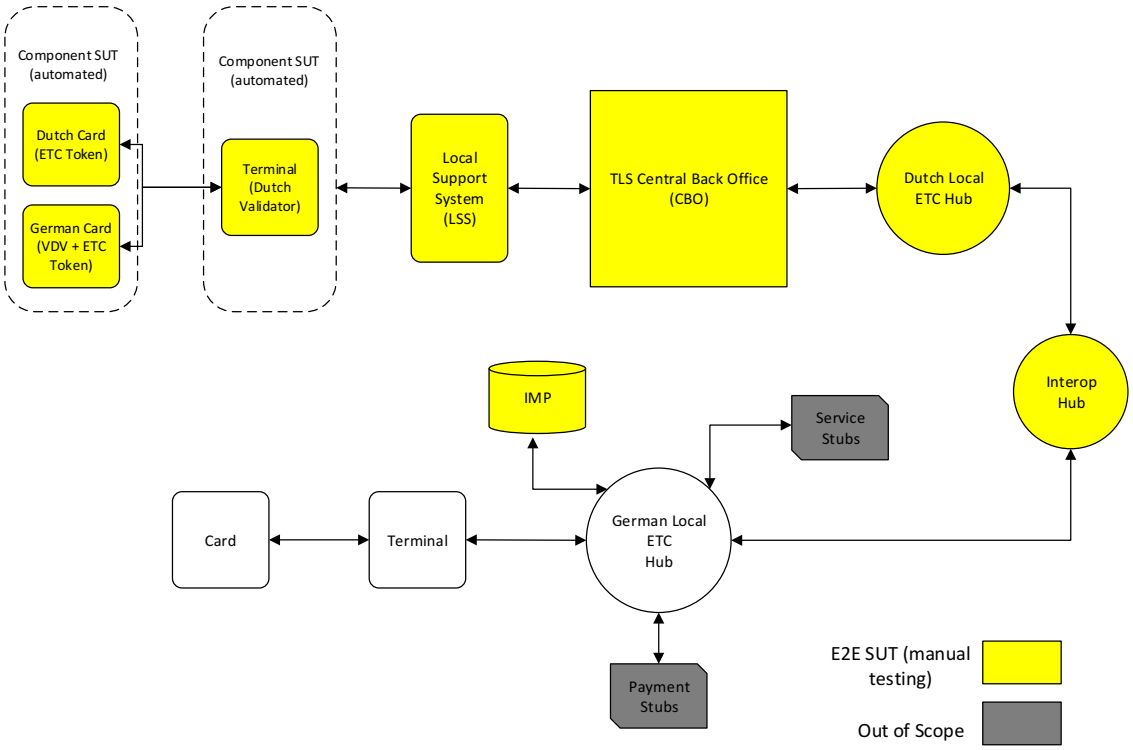

Figure 8: Scope of Integration Tests.

The approach for Pre-Pilot Testing remains the same as described in Section 7.2.4.

7.4 Test levels and test techniques

7.4.1 Test Suite Structure

7.4.1.1 Component tests to verify (automated)

- Card test harness (GST and version specific)
    - To exercise all card functions
    - Reduce risk of card defects
- Terminal test harness
    - To exercise all terminal interactions with card and with hub
    - Reduce the risk of defects in new terminal releases
    - What dependencies might there be for OEM terminals to be tested in isolation? E.g. existing dependencies on terminal management / configuration etc.

7.4.1.2 Integration Tests to verify (manually)

- Reference implementation (testing the code)
- A given terminal (OEM) within the lab
- A given pilot deployment
- A given sub-system (e.g. payment gateway etc.)

7.4.1.3 Performance tests to verify (manually)

- Reference back-office performance
    - To reduce the risk that the software architecture or implementation restricts performance such that transaction volumes cannot be attained
    - To ensure that tunings parameters and values behave as expected
    - To discover what value of configuration parameters might be best to achieve best performance
- Deployed pilot back-office
    - To remove the risk of deployment or configuration defects
    - Optimize configuration of pilot deployments

7.4.1.4 Endurance tests to verify (Automated)

- Card Test harness

8 Quality assurance and Change Management

The primary means to ensure the Quality of deliverables will be through reviews. After an internal review from UL, the test artefacts (MTP, test cases, test documents) will be released to relevant stakeholders with respect to the document. Based on the feedback, there might be a series of meeting to come to a consensus. The end result will be updated in the deliverables.

Apart from the above mentioned approach, other methodologies like inspections and walkthrough sessions, intakes, testing the test ware and the change management protocol would also be applied as and when needed.

8.1 Release advice

After the test cycle has been completed, a “Release advice” meeting will be scheduled. This meeting will be attended by: project manager, QA manager, test lead, business manager and any other stakeholder.

The agenda of the meeting will be to get a sign off from all the members listed above. It will start with the test lead providing a test summary and list all unresolved risks and any possible consequences in the production. All outstanding issues will be discussed before making a final sign off.

8.2 Change management and incident management

System changes and defects will be recorded and managed in a central system. At least one UL team member will be granted access to this system. Defects found by the UL team will be recorded and maintained on the Jira service, on behalf of the whole UL team, by the person(s) which have been given access. This includes doing queries and extracting reports as needed by the UL team. System change which are not initiated through issues reported by UL, will be recorded and managed by 42Tech as is currently the case.

Defects and changes, recorded as described above, will be prioritized and associated with planned software releases by OTI and 42Tech (possibly in consultation with UL and other pilot partners). Having a central release management system his will allow team of the various organizations to have visibility of upcoming changes and releases.

During the pilot deployment testing and thereafter, pilot partners might also need to report issues or defects. The process for handling such situations still needs to be determined.

8.2.1 Change management strategy

A change advisory board will be constituted which will look into matters of system modification. The Project manager, lead developer, QA manager and the test lead will be a part of this among other relevant members. The advisory board will have at its disposal an updated Configuration Management Data Base (CMDB). The CMDB will provide an overview of

components and the relation between them in the system. If the errors found warrant a system modification or in an event of a system modification, the advisory board will analyse the impact of the change on the related components in the systems. Based on the analysis the advisory board will raise a Request for Change (RFC) to the concerned parties. If the RFC is approved and the changes implemented then a testing cycle will be done to endure optimum quality and standard.

{When available, add a current change mgmt. strategy}

8.2.2 Incident management strategy

On a broad level, the following steps will be in place to ensure normal service operations:

- Incident logging and categorization
- Multiple level of support
- Incident monitor and escalation
- Incident closure and evaluation
- Inform users (proactive)
- Incident management reporting

{When available, add reference to a more detailed incident management strategy}

8.3 Discharge and transfer

[Describe the procedure after the discharge and the transfer is managed, such as (to whom the deliverables are given and which regulations apply for this transfer. The products are not only test documents but also software, configuration settings of cards, test images and more.]

9 Infrastructure and tooling

9.1 Introduction

The infrastructure and tooling described here is limited to the testing within UL's scope, as the relevant details of pilot partners and their suppliers are not available.

9.2 Test environment

Component Testing Environment

E2E Lab Testing Environment
The E2E Lab is set up in a Travel Lab consisting of a Production Environment and a Test Environment. The breakdown of the Production and Test Environment is provided in [2] .

Pre-Pilot Testing Environment

Pilot Deployment Testing Environment

9.3 Test tooling

Component Testing

- Collis Test Manager Version 2.6.1 and above
- GST Functional Test Suite
- STAS Functional Test Suite

Performance Testing

- Collis Test Manager Version 2.6.1 and above
- GST Functional Test Suite
- STAS Functional Test Suite

Endurance Testing

- Collis Test Manager Version 2.6.1 and above
- GST Functional Test Suite
- STAS Functional Test Suite

Bug tracking Tools

- Mantis issue tracking tool (used internally by UL)
- Jira (used by 42 Tech, UL test team will have access)

10 Deliverables

10.1 Introduction

The test deliverables described here is limited to the testing within UL's scope, since the test deliverables of pilot partners and their suppliers are not available.

10.2 Deliverables

Number	Deliverable
D1	GST v2.1 Functional Test Report
D2	GST v2.1 Detailed Execution Report
D3	E2E Test Case List
D4	E2E Test Case Specification
D5	E2E Test Results for all cycles
D6	E2E Test Run Dynamic Linking Libraries (DLL) for all cycles
D7	Exception Test Lists

Table 15: List of Deliverables

References

Ref.	Title	Author	Status	Version	Date
[1]	Grant Agreement-636126-ETC-4				4/12/2016
[2]	Travel Lab Expansion Plan ID v0.95			0.95	07/01/2015
[3]	milestones & deliverables				
[4]	20160324_Project Plan Pilots_v_0.1			0.1	03/24/2016
[5]	H2020 Test Overview_29.01.2016				01/29/2016
[6]	ETC_CA_H2020 version 2.0 final 02042015			2.0	02/04/2015