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Systems Engineering
Company H

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System Test Description

BEUMER Group

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1 Version History

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2 Scope

2.1 Identification

The system of interest is the Baggage Handling system, which is an extension to an already implemented CRISBAG provided by BEUMER. Please refer to the case description for more information [1].

2.2 System Overview

The purpose of the SOI is to extend the CRISBAG system with additional screening, specifically SecureScreen RX 5001 level 3 screening machines.

2.3 Document Overview

The system test description (STD) describes the test preparations, test cases and test procedures to be used to perform qualification testing of the system or subsystem.

The document structure and setup is inspired by the SE Casebook [2].

3 Reference Documents

System Requirements Specification, id: SRS-02-00-JJ_RC_MB_MJE-v02_1-20210404.
Detailed Design Document, id: DDD-01-00-MJ_TM-v01-20012021.
Preliminary design, id: PDE-01-00-ALL-v01-20210704

4 Test Preparations

This section describes the unique systems acceptance tests and the preparations needed to accomplish them. The focus will be on the systems test and not the individual system requirements specified in the SRS document, however the systems tests will reference system requirements when relevant.

Ideally a test should be present for each system requirement to convey that the system satisfies stakeholder expectations and requirements. It takes time and resources to describe tests and it has therefore been decided to keep it at a system level. The system level tests will focus on the different steps the luggage could possibly go through and that the system is functioning as it should at these steps. The flow diagram shown in the preliminary design, but again in figure 4.1, shows the different steps. For each

step it is possible to describe tests that will also map to some of the requirements specified in the system requirements document.

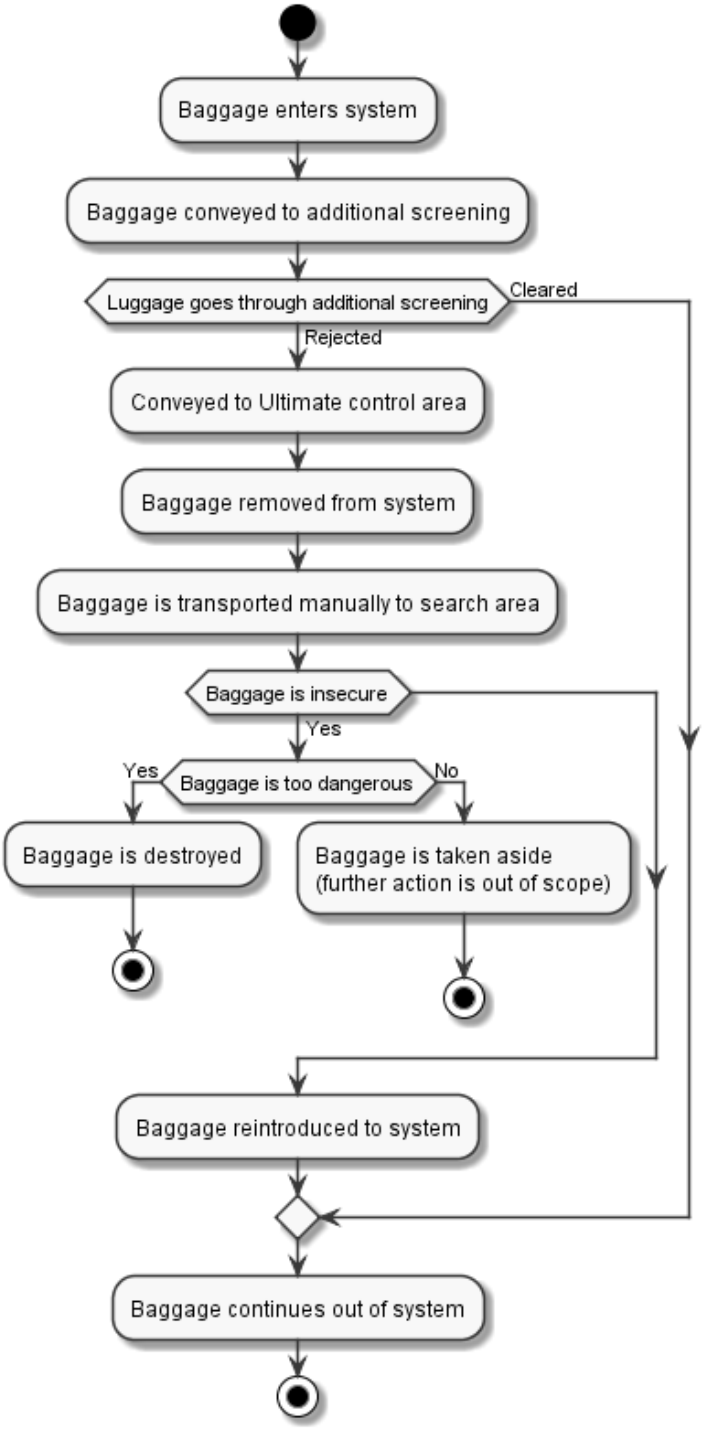

Figure 4.1: The flow diagram describes the different steps the luggage goes through from entering the extension until it is either cleared from the system or destroyed.

4.1 System Acceptance tests

The system acceptance tests are based on the luggage flow diagram. Each test is coupled to one or several system requirements, which can be seen in the traceability matrix, see **6 Requirement Traceability**.

TS1 Luggage conveyed to additional screening from original CRISBAG system.

TS2 Luggage is discharged from tote before going through the RX5001 machine

TS3 Luggage goes through additional screening and is deemed either secure or insecure

TS4 Luggage is automatically placed onto the same tote after having gone through the RX5001

TS5 Luggage conveyed to Ultimate control area

TS6 Luggage is either deemed secure or insecure at the Ultimate control area

TS7 Luggage is conveyed back to the original CRISBAG system.

4.2 Hardware preparations

All the systems test are dependent on the building blocks provided by BEUMER group (see figure 1 in [1]) as these components constitute the physical framework of the system. It is not necessary to have the entire framework operational to test each test, however some parts of it must be functioning (depends on the test). The RX5001 Scanner must also be available (provided by client, airport) as some tests are reliant on the response from luggage scans (tests part of the additional screening).

A sketch of the physical framework can be seen on figure 4.2. An example could be TS1, where the *Discharger* component must be connected to *Transport* components and conveyor belt to remove the luggage from the *Tote* otherwise the test cannot be carried out.

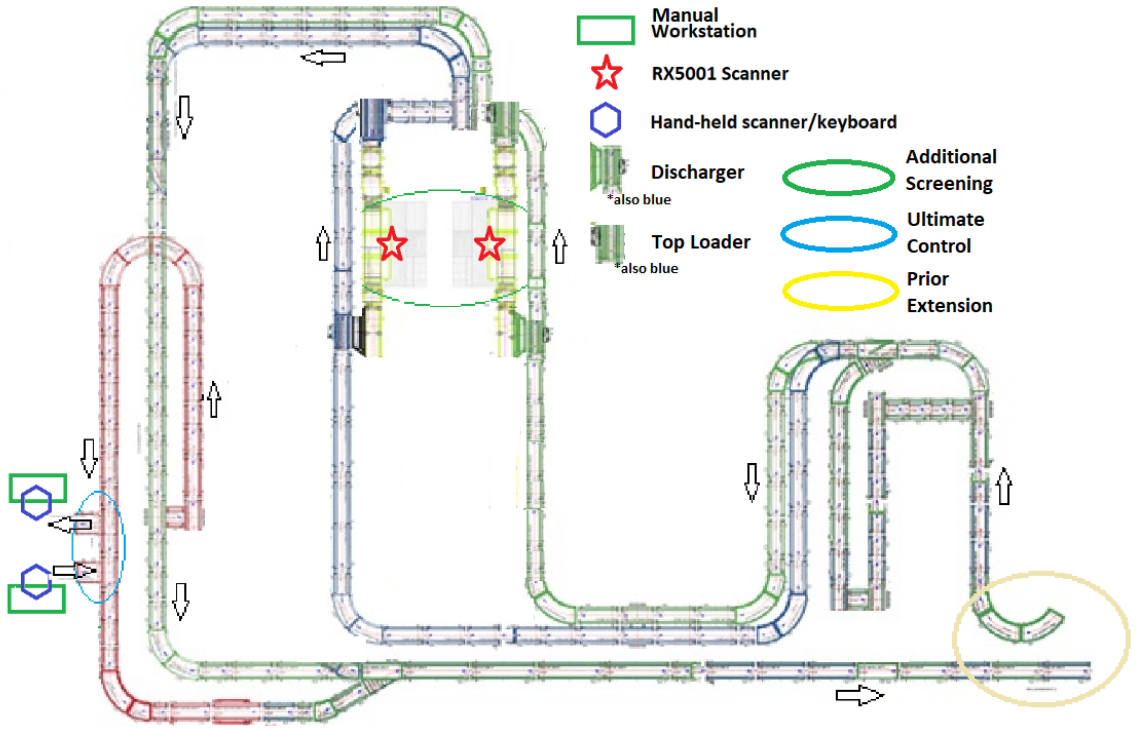

Figure 4.2: System sketch with components.

4.3 Software preparations

Hardware components are an essential part of the system as luggage needs to be physical moved from one place to another. The individual hardware subsystems have interfaces to different software systems and without them they cannot operate. The connections and interfaces between software and hardware is described in the detailed design document. Figure 4.3 illustrates the relationships between software modules and hardware components. The entire software system is not required to be operational for all tests as some can be 'stubbed' for the individual tests.

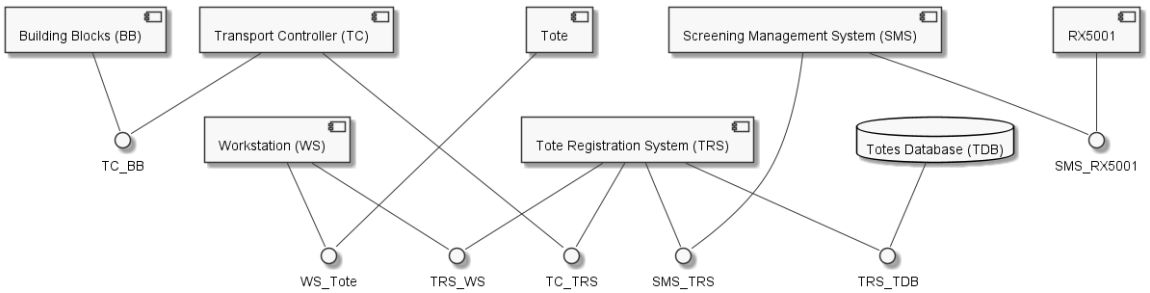

Figure 4.3: Interface diagram that shows the interfaces between components in the system.

5 Test Descriptions and expected behaviour

5.1 Luggage conveyed to additional screening (TS1)

In TS1 the test will focus on the time it takes for each piece of luggage to be transported from the entry of the system to the additional screening area and if the luggage is transported this distance correctly, which means that all system components involved in the transportation of the luggage from the entry of the system until the additional screening area functions correctly. The time it takes the luggage to be transported should be no less than 70 seconds and no more than 30 minutes.

Preconditions
The prerequisites to do the test is that all the building blocks of the system from the entry of the system until the additional screening area. This excludes building block that are part of the additional screening area, so it excludes the discharger, that separates the luggage from the tote. It is also important that the Transport Controller that controls the speed of the assembly also works. Before the test the assembly line should be running with a speed that would be able to transport luggage from the entry to the additional screening area in 120 sec.

Test process
The different steps of the test process is described below:

1. Luggage is added to the assembly line with an interval of 5 seconds. This process will continue through the whole test.
2. At a specific point of the assembly line, that is the start of the assembly line, a timer should be started for every piece of luggage added to the system.
3. Right before the additional screening area (where the side-loader building block is) the timer started in last step should be stopped.
4. The test is stopped when 200 pieces of luggage has arrived at the additional screening area.

Postcondition
After the 200 pieces of luggage has been transported from the entry of the system to the additional screening area the test result can be found. The test will pass if it takes the luggage more than 70 seconds and less than 30 minutes to arrive at the additional screening area.

5.2 Luggage is discharged from tote before going through the RX5001 machine (TS2)

In TS2 the test will focus on the operation of the discharger, where the luggage is removed from the tote and passed to the RX5001 scanner for screening.

Preconditions
The transportation and conveyer belts must be powered and ready to move the luggage through the system. The RX5001 scanner does not have to be powered on, since the module getting tested are the dischargers.

There should also be 200 pieces of luggage on the first part of the system, which will be used for the actual test of the dischargers.

Test process
The different steps of the test process is described below:

1. Luggage is added to the assembly line with an interval of 5 seconds. This process will continue through the whole test.
2. When every piece of luggage reach the discharger note that each piece is discharged from the tote to the next conveyor belt.
3. The test is stopped when the 200 pieces of luggage have been discharged from the tote.

Postcondition
The 200 pieces of luggage all get discharged and sent to the next conveyor belt. The test will pass if all the bags are discharged without any damage to the system or the luggage.

5.3 Luggage goes through additional screening and is deemed either secure or insecure (TS3)

This part of the system starts after the discharger has separated the luggage from the tote and it ends with the luggage having been scanned by the RX5001. The RX5001 should be able to talk to the Screening Management System and Tote Registration System software and change the status of the different pieces of luggage going through it and should be able to change the state of a piece of luggage to either **Cleared by additional screening** or **Require manual inspection** .

Precondition
The RX5001 should function properly together with the building blocks for the assembly line that includes the discharger. The software for the Tote Registration

System and the Screening Management System should also function together with the interfaces between the two software modules.

Test process
The different steps of the test process is described below:

1. 10 pieces of luggage is added to the assembly line right after the discharger building block. This is done with an interval of 5 seconds between each piece of luggage.
2. Each piece of luggage is then transported through the RX5001
3. The test is done when every piece of luggage has been though the RX5001 and a state has been assigned to every piece of luggage.

Postcondition
5 pieces of luggage should be assigned the state **Cleared by additional screening** and the other five pieces of luggage should be deemed insecure and given the state **Require manual inspection**. This should be visible in the Tote registration system through its user interface.

5.4 Luggage is automatically placed onto the same tote after having gone through the RX5001 TS4

This part of the system is supposed to automatically place luggage screened by the RX5001 back into the same tote it was in before getting screened.

Precondition
The RX5001 scanner and conveyor belt going to and from the RX5001 scanner must be operational. The top-loader and discharger must be operational as well as totes need to be merged with luggage.

Test process
The different steps of the test process is described below:

1. The 10 pieces of luggage get loaded onto the system before the discharger.
2. Discharger seperates tote and luggage.
3. Luggage is scanned by RX5001.
4. Top loader puts the luggage into the tote.
5. Tote containing luggage exits the top loader on to transportation belt.

Postcondition
Luggage is back in the tote it originally arrived in. The test is passed if the luggage is

in the same tote as it was discharged from and no luggage has taken any damage.

5.5 Luggage conveyed to Ultimate control area (TS5)

In TS5 the test will focus on the transportation of luggage to the Ultimate control area. This test will make sure that the operation of the diverter between the green and the red track on figure 4.2.

Preconditions
The systems transportation belts must be powered and ready to move the luggage though the system. There should be 300 pieces of luggage ready at the beginning of the system and of those 300 pieces 150 should be marked as **Require manual inspection**. For convenience the insecure luggage should be red and secure should be green.

Test process
The different steps of the test process is described below:

1. 300 pieces of luggage is added to the assembly line with an interval of 5 seconds. This process will continue throughout the whole test.
2. When a piece of luggage reach the diverter it should be noted if it was red and which way it went.
3. The test is stopped when the 300 pieces of luggage have passed the diverter.

Postcondition
All 300 pieces of luggage reach the end of the system without any incidents. The test will pass if 150 pieces of red luggage have passed the Ultimate Control area and 150 pieces of green luggage has not passed the Ultimate Control area. If any of the luggage goes to the wrong position or any of the luggage is damaged the test will fail.

5.6 Luggage is either deemed secure or insecure at the Ultimate Control area (TS6)

In this test the handling of luggage in the Ultimate Control area is tested. The Ultimate Control area starts from the luggage is diverted to the ultimate control area after having been through the RX5001 and deemed insecure. Through the user interface for the Tote registration system either the state **Cleared by manual inspection**, **Removed from system to be safely stored** or **Removed from system to be destroyed**. The three states should be able to be accessed from the Tote Registration System afterwards.

Precondition

The assembly line should work correctly (or at least the part for the Ultimate Control area) which involves the Transport controller. The Tote Registration system should also function correctly together with its user interface.

Test process
The different steps of the test process is described below:

1. 15 pieces of luggage is added to the Tote registration system together with a Tote. Both the luggage and the Tote should be assigned an idea. That should be able to get scanned
2. 15 pieces of luggage together with a Tote are added to the assembly line from the start of the Ultimate Control area.
3. 15 pieces of luggage arrive at the manual inspection and are removed from their Tote and the luggage is scanned manually together with the Tote to be able to change the state.
4. Each of the 3 possible states that a piece of luggage can be assigned after manual inspection are assigned to a third (5 pieces of luggage) of all the luggage tested. The states are assigned through the user interface that is part of the Tote Registration system.

Postcondition
After the test all possible states should be assigned to all pieces of luggage (5 pieces of luggage for each state).

5.7 Luggage is conveyed back to the original CRISBAG system (TS7)

This test handles getting luggage back into the original CRISBAG system. Luggage deemed secure after the RX5001 circumvents the Ultimate Control, while luggage deemed secure in the Ultimate Control area is reintroduced to the return conveyor.

Precondition
Luggage is deemed secure, either in the RX5001 scanner or in the Ultimate Control area. The conveyor belts after the RX5001 scanners and from the Ultimate Control area all work as intended.

Test process
The different steps of the test process is described below:

1. 100 pieces of luggage is manually added unto the conveyer belt from the ultimate control area and is conveyed to the end of the system (at the entry of the system coming from the original CRISBAG system).

2. 100 pieces of luggage is deemed secure by the RX5001 and routed to the end of the system (at the entry of the system coming from the original CRISBAG system).

Postcondition
200 pieces of luggage arrive at the end of the system, where it should continue to the original CRISBAG system.

6 Requirement Traceability

See TraceabilityMatrix-03-00-TM-v03-20210421.pdf

References

[1] Beumer, "BAGGAGE HANDLING UPGRADE," vol. 2017, pp. 1–11, 2018.

[2] R. H. Jacobsen and S. Hallerstede, "Systems Engineering Cases and Instructions," [Online]. Available: https://blackboard.au.dk/bbcswebdav/pid-2945704-dt-content-rid-10601901_1/courses/BB-Cou-UUVA-94215/SECaseBook8.pdf.