Aarhus University
Systems Engineering
Company H

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Preliminary design

BEUMER Group

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1 Version History

Ver.	Date	Initials	Description
1.0	01-01-2020	TM, MJ	First draft of document.
1.1	18-03-2021	TM, MJ	Added Systen Context diagram, make or buy and software design sections
1.2	24-03-2021	TM	Added appendix and updated references
1.3	07-04-2021	RC	made a few changes

Contents

2 Introduction

The purpose of the Preliminary Design Review (PDR) is to formalize all of the information regarding your project into something that anyone without prior knowledge would be able to understand what was being attempted [1].

This document is inspired by the process for Preliminary Design Review [1].

References:
System Requirements Specification, id: SRS-02-00-JJ_RC_MB_MJE-v02_1-20210704.

3 Mission summary

See Statement of Work [2].

4 Requirements

All system requirements can be found in System Requirements Specification.

5 System Design

The next sections will describe the different systems, both external and internal elements. The focus will be on illustrating the big picture of the system landscape and not the specific implementation details.

5.1 System Context Diagram

The System Context diagram shown in figure 5.1 defines the actors, major hardware and software modules and the interfaces that exist between them. Detail is not important, the main focus is illustrating the internal and external dependencies for the system. The diagram is inspired by the c4model [3]. The elements are described in table 5.1.

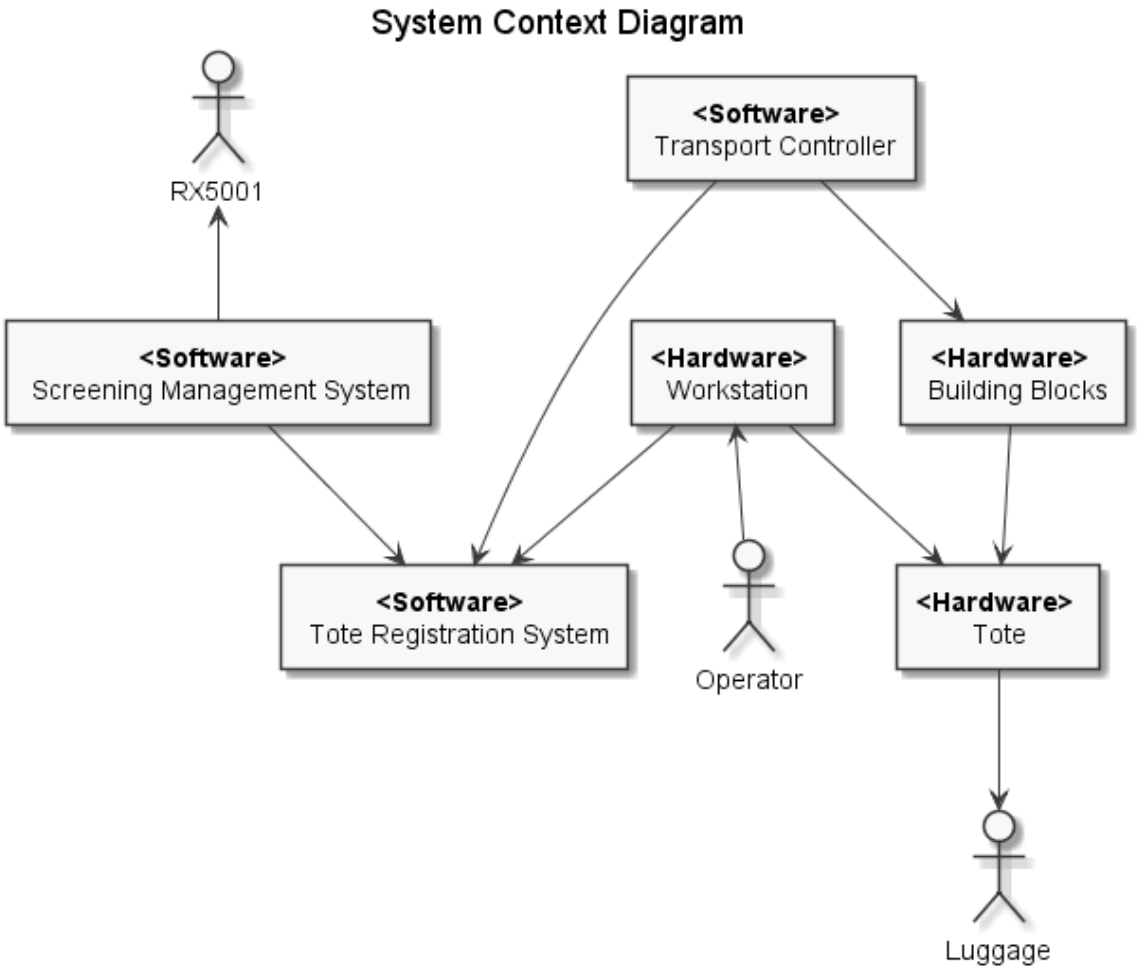

Figure 5.1: System Context diagram. High-level illustration of actors and systems and the interfaces between them. RX5001 scans luggage but is not part of the system scope. Tote is also technically a building block, but is not static and interact with other elements.

Table 5.1: Description of elements in the system.

Elements	Description	Alias
Transport Controller	Controls building blocks. Requests information about tote state from TRS.	TC
Tote Registration System	Persists information about totes and continuously updates tote state.	TRS
Screening Management System	Interface to the RX5001 scanner. Sends information about luggage state to the TRS.	SMS
Workstation	Physical workstation provided by BEUMER. Contains a hand-held scanner that can scan totes, which will send an update to the TRS.	WS
Bulding Blocks	Physical static building blocks from BEUMER. The entire transportation system is made from these blocks (e.g. transport, merge, top-load). See case description [2].	BB
Tote	A physical dynamic building block in the sense it is moved between elements in the system. Has barcode that is connected to the TRS and scannable by hand-held scanners at the workstations	TT

5.2 Product Breakdown Structure

Product breakdown structure is a hierarchical decomposition of a product [4]. Figure 5.2 breaks down the baggage handling systems into three major subsystems: Ultimate Control, Scanning Area and Transportation.

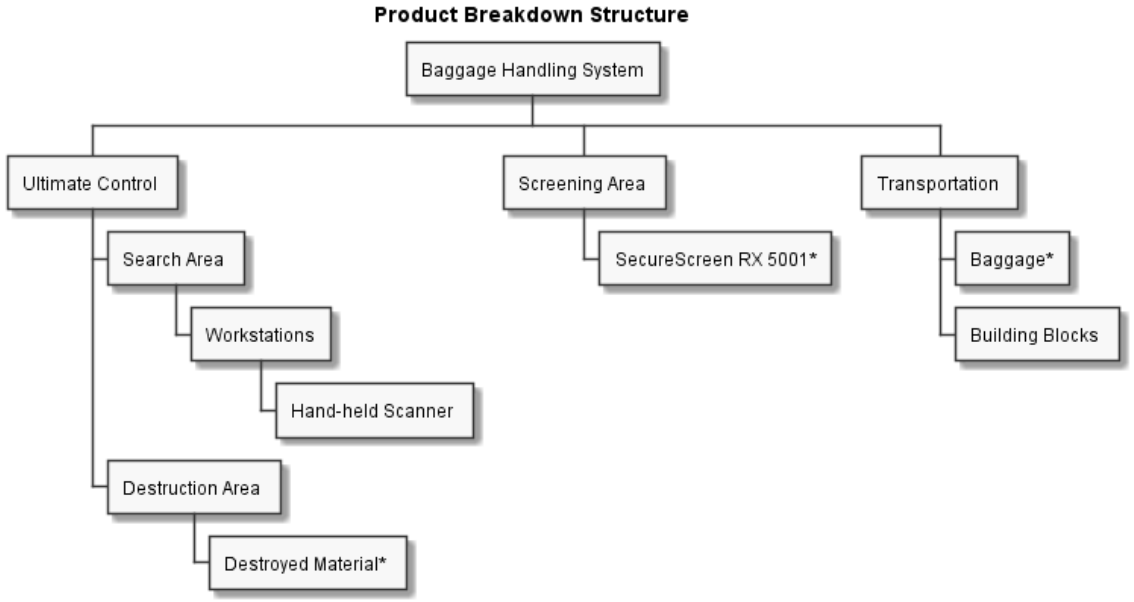

Figure 5.2: Product Breakdown Structure diagram. Illustrates major subsystems, where blocks marked with * are not explicitly part of the product. *Building Blocks* are components provided by BEUMER [2].

5.2.1 Make or Buy

Most of the components used for the system is purchased from BEUMER Group. This includes all the building blocks and manual workstations (including hand-held scanners) of the system shown in the case description [2]. Other components to take into consideration is the RX5001 scanner, which is a part of the additional screening area. This component is provided by the the airport.

Figure 5.3 illustrates the entire setup with essential components. The setup is updated with several new features based on change request received from the client **6.4 Appendix A**. All building blocks are made within BEUMER Group as well are all software modules.

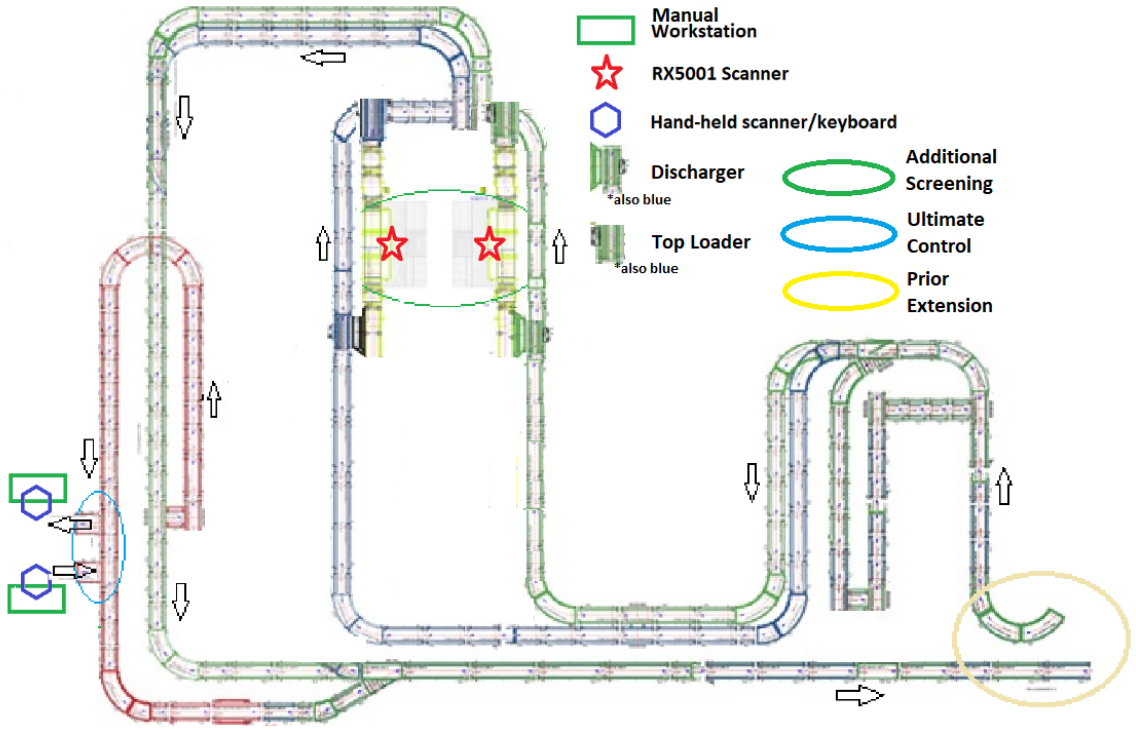

Figure 5.3: System sketch with components.

5.2.2 Quantity & Cost Estimate

The cost for the system is based on estimated work hours for developers and other employees. Table 5.4 illustrates different employees that are necessary to realize the system (the table is taken from case description).

Department	Role	Start	End	Time Commitment
Software	SW Project Manager	01/02/2020	31/12/2020	100%
Software	Software Architect	01/02/2020	31/12/2020	100%
Software	Developer	01/02/2020	31/12/2020	100%
Software	Developer	01/05/2020	31/12/2020	100%
Software	Developer	01/08/2020	31/12/2020	75%
Workshop	Electrical specialist	As needed	As needed	50%
Workshop	Mechanical specialist	As needed	As needed	50%
Commissioning	Commissioner	01/06/2020	31/12/2020	100%
Commissioning	Commissioner	01/08/2020	31/12/2020	100%
Commissioning	Commissioner	01/08/2020	31/12/2020	100%

Figure 5.4: Table showing time commitment from the working staff

Using this table it can be calculated that a total of approximately 61,75 months of pay. Including the double pay that is required for the SW developers when on client site, which is calculated for a 5,6 months of 30 days for all SW developers, this totals into approximately €144.703,13.

This is however only the salary for the staff and the components used in the project will have to be added to the price. To do this another table have been created which specifies the name of the units, number of each unit, price and time to install. The table can be seen in figure 5.5 below.

Element	Qty	Cost	Time to install
Tote	20	€250	0
Transport	120	€2.000	120 min.
Curve	25	€2.500	120 min.
Divert	8	€6.000	240 min.
Merge	8	€5.000	240 min.
90-degree Transfer	6	€7.000	360 min.
Discharge	12	€3.500	150 min.
Top-load	2	€4.000	120 min.
Workstations - Handheld scanner - Keyboard/touch Screen	2	€5.000	

Figure 5.5: Table showing the each unit needed, along with important information

Multiplying the number of units with their price and the summing up will be equal to a price of €497.500,00.

To get the total estimated price of the system the two number will have to be summarised, which equals €642.203,13.

5.3 Luggage Life Cycle

To understand the system and the different components that make up the system a Luggage Life Cycle is created in figure 5.6. The diagram shows the the different steps luggage goes through from entering the extension system to the baggage exits the system.

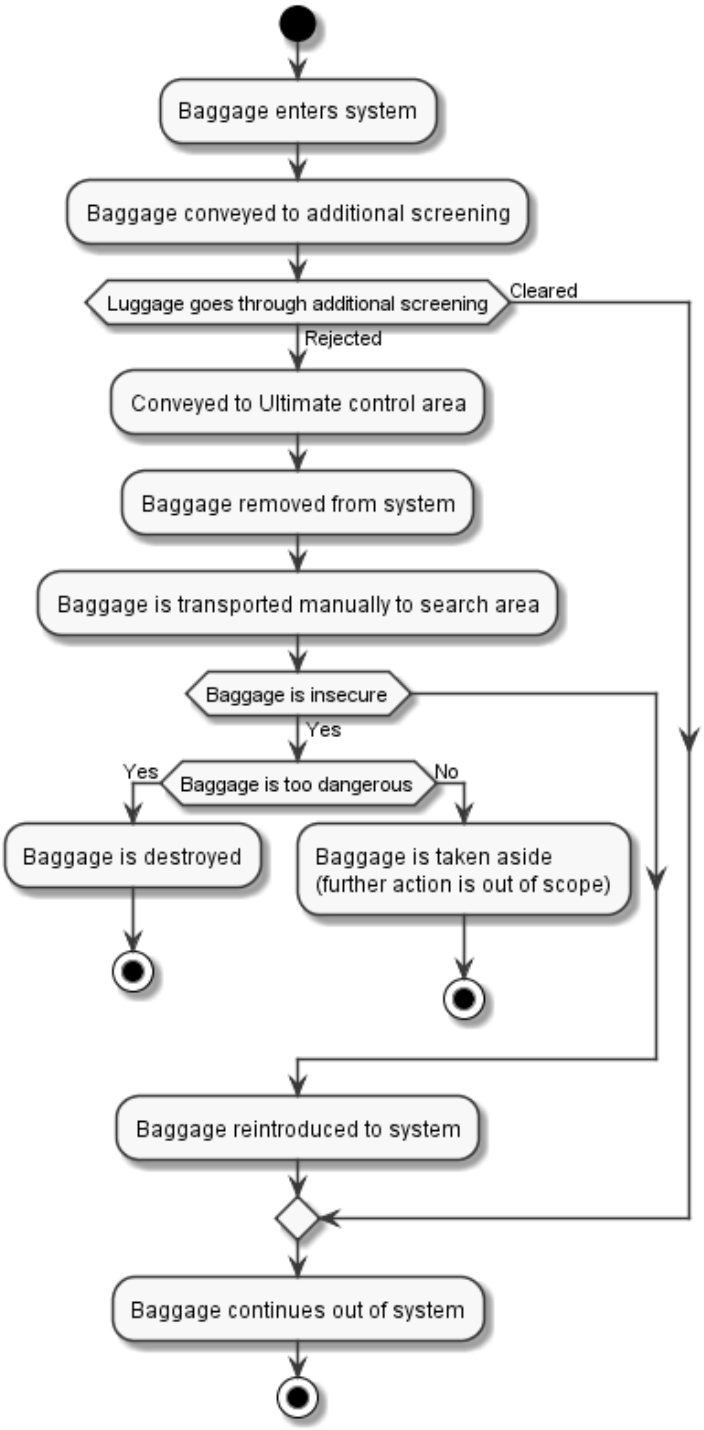

Figure 5.6: Flowchart diagram showing all the steps the baggage goes through

6 Top-level Software Design

6.1 Screening Management System (SMS)

The RX5001 scanner scans all luggage that pass through it. Based on what the scanner scans, different actions need to be taken. The SMS software should be able to interface with the Tote Registration System so that the totes with rejected bags can be rerouted to the Ultimate Control area. The SMS should also output the results of its scans so that human operators can get an idea of what is inside the bags that need to be manually examined.

6.2 Transport Controller (TC)

The transport controller handles the entire transportation system. This involves ensuring the correct transportation time intervals between sections, e.g. from additional screening until reaching entry point of manual inspection at least 30 seconds must pass. Another aspect of this is controlling transport/conveyor speed based on luggage capacity - if the throughput of luggage has surpassed max capacity it should stop/slow down.

The Transport Controller should be connected to the Tote Registration System. The TRS software contains the states of the totes and the Transport Controller 'subscribes' to the information to decide the routing of the tote. This could be deciding whether a tote should be redirected to Ultimate Control or directly back to the original CRISBAG solution. The state of the tote is also used when deciding if it is allowed to return to the system after manual inspection at one of the workstations.

6.3 Tote Registration System (TRS)

The Tote Registration System is responsible for persisting the states of the totes. It is designed as a mediator between SMS, TC and workstations, where SMS updates (publishes) the screening state of the tote to the TRS and then the TC can pull this information when it is required. The workstations uses the TRS software to update the status of manual inspection, this is triggered when an operator scans the tote with the hand-held scanner.

The Tote Registration System also provides a graphical user interface that can be used by the operator at manual workstations. Figure 6.1 shows a mock-up of the user interface. All totes are scanned when entering the system and stored. An operator can see all totes in the system and associated states. An operator can update tote states at workstations, this could be clearing the luggage after manual inspection or rejecting it.

Tote States:

- STATE 1 - Cleared by primary screening
- STATE 2 - Cleared by additional screening
- STATE 3 - Require manual inspection
- STATE 4 - Cleared by manual inspection
- STATE 5a - Removed from system to be safely stored
- STATE 5b - Removed from system to be destroyed

The Transport Controller should only allow luggage back from Ultimate Control if it is in state 4. Everything else should be rejected.

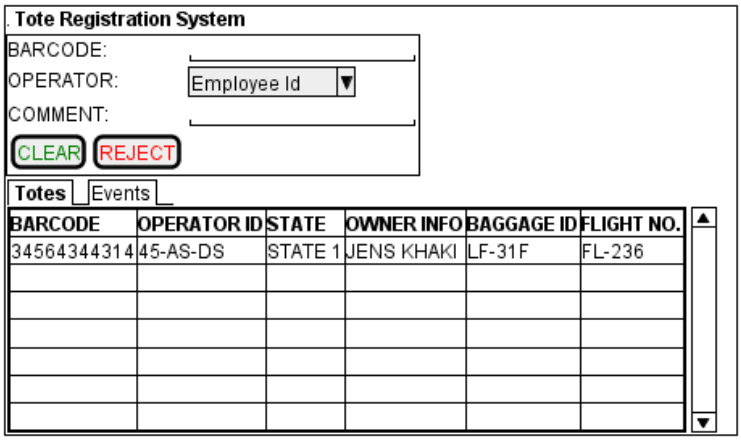

Figure 6.1: Mock-up of Tote Registration System.

6.4 Appendix A

BEUMERGROUP

BEUMER Group
Baggage Handling Upgrade

BAGGAGE HANDLING UPGRADE
LEVEL 3 X-RAY SCREENING
CHANGE REQUEST

Dear contractor,

We regret to inform, that our SecureScreen RX 5001 level 3 screening machines have failed to receive the certifications needed to perform in-tote screenings, in combination with your supplied CrisBag system.

After intensive dialog with the SecureScreen supplier, it has been concluded that it will not be realistic to modify the machines in due time, to be certified for use with the totes.

We therefore kindly request, that you modify the sorting system to be able to discharge all baggage to traditional conveyor lines, on which they can then pass through the SecureScreen RX 5001 machine.

Upon completed screening, the baggage must then be reloaded into the tote system, and continue as originally designed.

More specifically, please provide:

1) Updated drawing (or sketch drawing at first), illustrating the mechanical setup using as few traditional conveyors as possible. Everything except the actual screening machines must be included in the scope.
2) Additional relevant controls description, describing how the area is controlled, and if there are any limitations or problems introduced by this change.
3) Any additional cost imposed due to this change, here please split into mechanical, electrical, control and installation costs.
4) As our final deadline is fixed, please provide an updated time schedule showing how this can be achieved, without any impact on the already agreed deadlines.

Looking forward to your prompt reply.

On behalf of the airport

Chris Larimore

13 Mar 2021 **01**

References

[1] Arxterra, *Preliminary Design Review*. [Online]. Available: https://www.arxterra.com/preliminary-design-review-outline/.

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

[3] S. Brown, *C4 Model*. [Online]. Available: https://c4model.com/.

[4] Wikipedia, *Product breakdown structure*. [Online]. Available: https://en.wikipedia.org/wiki/Product_breakdown_structure.