***Oslo Lufthavn - BHS Terminal 1***

***Concept Verification -   
Automated Baggage Handling (ABH)***

***Baggage last-mile and first-mile processes***

***Needs for automation***



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# Introduction

## Avinor and Oslo airport

Avinor is a wholly owned state limited company under the Norwegian Ministry of Transport and Communications and is responsible for 44 state-owned airports.  
  
Over 3000 employees are responsible for planning, developing and operating an efficient airport and air navigation service. Avinor is financed via airport charges and commercial sales. The air navigation service is organized as a wholly owned subsidiary by Avinor. Avinor's headquarter is in Oslo.

OSL is the largest airport in Norway, serving as a hub for the other Norwegian airports. OSL handles approximately 30 million passengers per year, of the total 55 million passengers per year in Avinor.

## Purpose of this document

This document is a first draft for a high-level description of the ambitions and needs to improve the efficiency of the baggage handling processes that take place between the BHS and the aircraft through innovative and automated solutions.

These processes covers the loading (sorting), unloading and transporting of baggage between the BHS and aircrafts:

* “Last-mile” baggage handling for the last processes of a departing flight (LMBH)
* “First-mile” baggage handling for the first processes for an arriving flight (FMBH)

The document is submitted to organisations and vendors in a market investigation context, where OSL is building up their understanding of the market and matureness of related solutions. OSL is interested in feedback from the market and will use this feedback to refine the needs description to be as realistic as possible. The marked investigation activity does not cause any commitment from Avinor or vendors.

OSL is now in a sketch and exploration phase, in which the description of needs shall be refined and adjusted following feedback from the market. Based on the feedback regarding available solutions and development in the market, OSL will make a priority classification of the processes that are considered realistic for automation on a short-term, mid-term and long-term range.

**Note:** Please observe that Avinor is open for all approaches on how to address the needs for increasing efficiency and automation (not only limited to the approaches described in this document).

## Automation

All automation activities will require a seamless interaction with the surrounding infrastructure, in particular BHS, OSL airport database and user interfaces used by involved actors.

OSL focuses on the following departure last-mile and first-mile processes between the BHS system and the aircraft stand:

* Baggage delivered from BHS to an automated load cell, where an automated process ensures loading of bags into trolleys and containers.
* Automatic indoors transport of empty and full containers between load cell and intermediate storage
* Intermediate automatic storage of trolleys and containers (rack in one form or another)
* Automatic outdoor transport of empty and full trolleys and containers between intermediate storage and aircraft stand or proximity storage

OSL focuses on the following arrival first-mile sub-processes between the BHS system and the aircraft stand:

* Automatic outdoor transport of empty and full trolleys and containers between intermediate storage and aircraft stand or proximity storage
* Automatic unloading of arriving baggage into the BHS

## Forthcoming process

Following evaluation of this marked investigation OSL plans the following progress:

* Market invitation for a dialogue conference where vendors may propose solutions that will address the described needs (tentatively Q2-2020).
* Cooperation with governmental organisations for possible fund allocation.
* Invitation to pre-qualification for innovation contract (tentatively Q3-2020).
* Initial innovation contract for development and installation of early versions of the proposed solution needs (tentatively Q4-2020 or Q1 2021), one or multiple provider).
* Final innovation contract for delivery of full-scale solution to be incorporated in conjunction with the new BHS system (one provider).

## Structure of document

This document contains the following main elements:

* Chapter 2: General background, describing common principles and terms
* Chapter 3: Departing last-mile bag processes, covering the needs related to handling bags from the BHS to the aircraft
* Chapter 4: Arriving first-mile bag processes, covering the needs related to handling bags from the aircraft into the BHS

## Terms

The following terms are used in this document:

| **Term** | **Description** |
| --- | --- |
| Bag | Abbreviation for one baggage item. One differentiates between standard, oversize and non-con baggage. |
| Bag storage | Integrated part of BHS where baggage is stored before being sent to sorting positions. Bag storage differs from EBS by newer technology, which provides a significantly higher delivery capacity. |
| Batch handling | Principle of how baggage for departing aircraft is sorted. Early baggage for a flight is actively retrieved ("Pull") for scheduled sequential sorting, while late handed baggage is sent to parallel sorting ("Push"). |
| BHS | *Baggage Handling System.* The baggage handling system at Oslo Airport consists of three separate systems, BHS-T1, BHS-T2 and BHS-UØ, with separate control and sorting systems. T1 and T2 have a physical cross connection, so bags can be transferred between the systems, while BHS-UØ is a standalone facility. |
| BHS-T1 | Refers to the baggage handling system in T1 that shall be replaced. The system is physically integrated with BHS-T2. |
| BHS-T2 | Refers to the baggage handling system in T2, containing a Vibes control system with a conveyor sorting system (supplier Vanderlande). The system is physically integrated with BHS-T1. |
| Bin | Position where standard baggage is delivered from the BHS system for further handling by handlers (also see sorting position). A bin can be regarded as a larger container into which standard baggage is sorted (intermediate storage) for a given flight. There must be adequate space in front of a bin for the trolleys onto which baggage is placed for transport to aircraft. When the bin is full the handler must remove bags before further bags are delivered. |
| Carousel | A conveyor belt that runs in circles, to which baggage is sent for further offloading and transport to aircraft. A carousel is normally used for OZ baggage that cannot be sent to bins, but it is also used for standard baggage when there are no bins that can be used. A handler must manually sort bags on the carousel to the correct trolley. When the carousel is full the handler must remove bags before further bags are delivered. |
| Container | Unit used for transporting bags within the airplane (also denoted ULD). Containers are owned by the individual airline and typically have a capacity of 30-40 bags depending on the size of the bag. |
| Control system | The system that controls the operation of the baggage handling system. |
| Dolly | Surface with wheels for transporting a container. Dollies may be connected to form a “train” and are pulled by means of a tractor. |
| FIDS | Flight Information Display system, allowing all relevant flight information to be presented to passengers, baggage handling personnel and other relevant target groups. |
| First-mile processes | Denotes the baggage handling processes taking place for an arriving flight, from the bags are loaded in a load carrier until the bags are unloaded into the BHS. |
| Handler | Refers to a company that provides ground services to airlines upon aircraft arrivals and departures, both with respect to passengers and baggage handling. |
| Lateral | Makeup position consisting of a conveyor belt, where bags are delivered from the BHS. When the lateral is full the handler must remove bags before further bags are delivered. |
| Last-mile processes | Denotes the baggage handling processes taking place for a departing flight, from the bags are delivered in the makeup area until they are loaded into the aircraft. |
| Load carrier | Common name for trolleys and dolly, i.e. a unit used for carrying baggage, either loosely loaded in a trolley or packed in a ULD. |
| Load cell | A group of sorting equipment within the makeup area, typically consisting of a speed-loader for sequential sorting and a set of sorting points for parallel sorting |
| Unloading position | Denotes the place where a handler feeds baggage into the system, typically for arrival baggage and transfer baggage. |
| Makeup | Used as a term for sorting baggage to the correct destination, i.e. moving baggage from BHS to a specific flight or from a specific flight to BHS. |
| Makeup area | Area within a pier where baggage is delivered from the baggage handling system to sorting before it is then brought to the aircraft by a handler, and where baggage is delivered from the aircraft into BHS. Also called PMZ (*Pier Makeup Zone)*. |
| Makeup position | Refers to the position within the makeup area where baggage changes responsibility between the BHS system and the handler. For departure flights the bags are delivered from the BHS system to a bin, lateral, carousel or speed-loader for further handling by a handler. For arrival flights the bags are loaded by a handler into an arrival loading position for further handling by the BHS. |
| OZ bag | Oversize baggage, i.e. baggage that is too big to be sent on a standard baggage belt meaning that special oversize desks and conveyor belts must be used. This document does not focus on OZ bags. |
| Pax | Abbreviation for passenger. |
| Pier | The part of the terminal where baggage is sorted for aircraft (Pier East, Pier West or Pier North). The term is also used for the passenger processes, but in this document the focus is on the baggage processes at ground level (airside). |
| PMZ | Pier Makeup Zone, see makeup area. |
| Pull | Specifies batch handling principle that actively orders (pulls) a batch of baggage for sorting upon request from the handler. |
| Segregation | Grouping of bags that allows them to be effectively managed at the remote destination. Typical segregations are Economy class, Business class, VIP, Crew and Transfer (with a possible segregation per transfer destination). When using trolleys there are normally 1-2 segregations, whereas when using containers there will normally be used one segregation only per container. |
| Speed-loader | Tool for semi-automatic loading from BHS to load carrier, consisting of a specially adapted baggage belt that can be operated by trades in horizontal and vertical direction. Delivery of bags are controlled by the operator and assumes the presence of a nearby buffer to ensure immediate delivery. |
| Standard bag | Standard item of baggage, i.e. a bag that can be fed in at ordinary check-in desks. This document has focus on standard bags. |
| Trolley | Carrier device for transporting bulk baggage between BHS and the aircraft. OSL has approx. 750 trolleys available in a common pool for handlers, consisting of a cage on top of 4 wheels. The trolleys may be connected together to form a train and is pulled by a tractor. |
| ULD | Unit Load Device; short name for container. |
| Vanderlande | Provider of the current BHS-T1, BHS-T2 and BHS-UØ. |

Table 1 Terms

# General background

## Baggage handling system

OSL operates 3 different baggage handling systems (BHS), of which the oldest in Terminal 1 (BHS-T1) stems from the inauguration of OSL airport in 1998.

The BHS-T1 system has end of product life in 2025, and OSL is now preparing for a replacement with a planned construction period between 2023 and 2027/2028. The new BHS system will follow a standard procurement process starting Q2-2020. Please observe that this document does not interfere with the needs and procurement of the BHS system itself, which will be handled separately.

The new BHS shall be contained within the same building venue as today, and with increased capacity requirements there is a need to increase not only the efficiency of the BHS operation, but also the processes beyond the BHS system.

The figure below illustrates the layout of OSL airport, where the square text boxes indicate the location of the central BHS-T1 baggage areas (MBH - Main Baggage Hall and PMZ – Pier Makeup Zone).

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Automatisk generert beskrivelse  
Figure 1: Location of BHS-T1 central baggage areas

## Baggage handling processes

The overall responsibility of the BHS system is to handle all delivered bags from check-in, arrival and transfer infeed points, until the bag has been delivered either to a makeup position within a load cell for outgoing baggage or an arrival carousel for arriving baggage.

The figure below illustrates the BHS flow of bags for the departure and arrival processes:



Figure 2: BHS departure and arrival processes

BHS-T1 will contain a centralized bagstore, where bags that arrives in good time prior to STD are stored:

* Approximately 70% of bags appear early enough from check-in and transfer to be stored in the bagstore. These bags will be delivered to the makeup area when the handler requests a batch (pull) delivery, or when a flight is opened for (push) delivery a predefined amount of time before STD
* The remaining 30% of bags appear too late to be store in the bagstore and will be delivered directly to the makeup area.

## Baggage handling last-mile and first-mile processes

Within the last-mile and first-mile processes, baggage is transported in trolleys or containers (ULD), commonly denoted as load carriers.

The involved manual work has to a large extent remained unchanged over the past 50 years. Although a number of tools have been taken in use, manual lifting and transporting of baggage units still accounts for a high proportion of the handling costs for the airlines.

The industry is moving towards more automation, but so far there is no major implementation in place covering the last-mile or first-mile processes. In comparison, this is essentially different from logistics within warehouses, where automated inventory management and automated transport are in widespread use and greatly increasing.

Avinor has a strong focus on innovation to achieve efficiency and meet future needs. In connection with the establishment of a new T1 baggage facility, an opportunity opens up to ensure innovation in baggage handling.

OSL has an ambition to automate the last-mile and first-mile processes as far as possible for standard bags, thereby improving health and environment conditions, gaining increased efficiency and reducing operational costs. This will provide an opportunity to improve the working environment for handlers, which today is characterized by manual lifting of bags with varying weight and size.

Avinor has a number of other airports that will be rebuilt or upgraded in the coming years, and the aim is that any derived concepts and solutions at OSL may be transferred to other airports.

Departing baggage

The following figure illustrates the processes for departing baggage:



Figure 3: Departing BHS and last-mile processes

The last-mile processes for departing flights with direct interface to the BHS system consist of:

* Transporting empty trolleys and containers from external storage into the BHS makeup area
* Loading (sorting) baggage received from the BHS into trolleys and containers
* Transporting full trolleys and containers from the BHS loading (sortation) area to the aircraft stand, or into an intermediate store if the aircraft stand is not available

Arriving baggage

The following figure illustrates the processes for arriving baggage:



Figure 4: Arriving BHS and first-mile processes

The first-mile processes for arriving flights with direct interface to the BHS system consist of:

* Transporting empty load carriers to the aircraft stand
* Transporting full load carriers from the aircraft stand into the BHS unloading area
* Unloading full load carriers into the BHS
* Remove empty load carriers from the BHS makeup area

## Concept Verification Centre

OSL will establish a “Concept Verification Centre” (CVC), where various concepts can be developed, tested and verified to meet the needs in the years ahead. The idea is to incorporate accepted solutions for production in the new baggage facility which starts production around 2025 and should be fully completed by 2027.

The CVC will be built directly north of pier North as illustrated in the figure below, covering an area of ​​approximately 1500 m2 which shall be ready for use early 2021.



Figure 5: Location of planned Concept Verification Centre

When building a new BHS with increased capacity, there is a strong need to focus on the logistical processes. Introducing automation and changing operational procedures will affect the last-mile and first-mile processes and the corresponding need for available physical areas. OSL is working to ensure the availability of areas for loading, unloading and transporting facilities, and plan to tests the principles in the CVC.

When developing and evaluating improved operational concepts it is crucial that one looks at the whole, i.e.

* Involving all relevant actors in the last-mile processes
* Ensuring necessary integration with the BHS
* Considering the available area for logistics

## Load carriers

Load carrier is the common denomination for trolleys and containers that are used to transport bags between the BHS and the aircraft.

The automation of baggage handling that involves trolleys and containers will require different solutions due to their different physical characteristics. It is considered that it is easier to automate handling of containers than trolleys, and that these should be addressed in different activities. At the current stage this document does not differentiate the needs for automation between trolleys and containers, however this is a topic that shall be clarified during the process of ongoing specification work.

|  |  |
| --- | --- |
| Trolleys  Trolleys are used to transport bulk (loose) baggage to the aircraft, where bags are loaded into the aircraft belly. A trolley may typically contain up 35 bags, depending upon bag size.  Each trolley consist of a chassis with 4 wheels, and a fixed transport cage on top for baggage. Bags are loaded from above.  Trolleys are managed through a pool, where all handlers have access to any trolley within the pool following a commercial agreement. OSL has approximately 750 trolleys available. | Et bilde som inneholder innendørs, bygning, bilvei, gulv  Automatisk generert beskrivelse  Figure 6: Trolley for bulk baggage |
| Containers (ULD)  Containers are used to transport baggage to the aircraft, where the container is loaded into the aircraft belly. A container may typically contain up 40 bags, depending upon bag size. The containers are lightweight structures that are transported on top of a dolly.  While containers are owned by each individual airline, the dollies are owned by the ground handlers. | Et bilde som inneholder lastebil, bilvei, bygning, utendørs  Automatisk generert beskrivelse  Figure 7: AKE containers for baggage |

Some details on the commonly used containers at OSL:

* Primarily 2 types of containers “AKE” and “AKH” are used, with measures as shown in the figure below (black numbers are centimetres)
* The load surface of both types is 156 x 153 cm (may vary with some cm)
* The leftmost container as well as the photo above are AKE, which are loaded from the side. The horizontal footprint is 200 x 153 cm at the height of 49 cm above the load surface (making it stick out on one side). Height is 163 cm.
* The rightmost container in the drawing below is AKH, which are loaded from the side and also partially from the top. The horizontal footprint is 244 x 153 cm at the height of 49 cm above the load surface (making it stick out on both sides). Height is 114 cm.

|  |  |
| --- | --- |
|  |  |

Figure 8: AKE (left) and AKH (right) containers

# Departure Last-mile Bag handling

This chapter describes the departure “last-mile” bag handling processes, focusing on the potential for automation.

The main principles are described, followed by a description of processes where OSL has an ambition to automate as integrated and seamlessly as possible.

## Main principles

Departing bags are loaded into the BHS system as local check-in bag or as transfer bag from an arriving flight.

The responsibility for departure bag handling is divided as follows:

* All processes from the bag is loaded into BHS until it is delivered to the makeup area are handled by the BHS system, where the airport has the responsibility.
* All processes thereafter until the bag is in the aircraft are handled by the last-mile processes, where the handler has the responsibility

The figure below presents a high-level overview of the baggage flow, divided into the BHS processes and the last-mile bag processes:

* The departure makeup area is illustrated by the red box
* Dotted arrow indicates delivery of the individual bag
* Fully printed arrow indicates transport of bag on a load carrier, indicating green for empty and blue for full



Figure 9 Departing baggage flow

The load cell and intermediate storage should, as a main principle, be located within the same building to facilitate automated transport between them.

The following sections describe the various elements of the departure last-mile bag handling processes. Please note that the content is indicative and shall be specified in more detail.

### Departure makeup processes

The departure makeup processes cover the following sub-processes:

* Transporting empty load carriers to an intermediate storage
* Storing empty load carriers in an intermediate storage
* Transporting empty load carriers to a load cell
* Loading bags onto load carriers
* Transporting load carriers to an intermediate storage
* Storing full load carriers in an intermediate storage
* Transporting load carriers from intermediate storage to aircraft or optionally to a proximity storage



Figure 10 Departure makeup processes

### Departure makeup area

The departure makeup area consists of a set of load cells, closely connected to an intermediate storage for a limited number of empty and full load carriers.

The departure makeup area will employ the same principles in PMZ east and west. Since PMZ east is expected to have a higher degree of container usage than PMZ west, the size and layout of the individual load cell is expected to vary and remain to be specified.

### Departure makeup principles

The new BHS-T1 will allow makeup of bags in two separate modes: Push and Pull (batch) mode.

Push mode

The current departure makeup area is filled with 87 sortation points («bins»), where bags are stored the last 2-3 hours before STD according to the push concept.

When using push mode, the bags are sorted in 2 different periods. This is primarily used for flights with a small volume of bags, where the need for segregation is low and the total load time is limited (typically domestic flights):

|  |  |  |
| --- | --- | --- |
| **Period** | **Time before STD** (defined per flight) | **Description** |
| **Early** | Until 15-20 min | BHS delivers bag continuously as they are available, using a few makeup positions for segregation (e.g. by using carousel, bin, lateral or speed-loader). |
| **Dump** | Approx. 0-20 min | BHS delivers bag to a common pickup position, where handler evaluates if bag may reach the flight or not |

Table 2: Period for push makeup

The figure below illustrates push mode where bags are sorted in parallel during the Early period and finally managed in the Dump period:  
  
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**Figure 12 Makeup periods with push makeup**

Pull (batch) mode

The new BHS system will support the batch (pull) concept which will significantly reduce the number of makeup positions as compared to the current situation.

When using pull (batch) mode, the bags are sorted in 3 different periods. This is primarily used for flights with a high volume of bags, where the need for segregation is present and the total load time is high (typically international flights):

|  |  |  |
| --- | --- | --- |
| **Period** | **Time before STD** (defined per flight) | **Description** |
| **Early** | Until approx. 60 min | Handler plans and orders sequential sorting to sorting point (e.g. using a speed-loader) |
| **Late** | Approx. 30-60 min | BHS delivers bag continuously as they are available, using multiple makeup positions for segregation (e.g. by using carousel, bin, lateral or speed-loader). |
| **Dump** | Approx. 0-30 min | BHS delivers bag to a common pickup position, where handler evaluates if bag may reach the flight or not |

Table 3: Makeup periods for push makeup

The figure below illustrates pull (batch) mode where bags are sorted sequentially during the Early period, then sorted in parallel during the Late period and finally managed in the Dump period:

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Automatisk generert beskrivelse

Figure 13 Makeup periods with pull (batch) makeup

### Load cell

The load cell contains a set of makeup positions, consisting e.g. of one speed-loader and a set of makeup positions (bin, lateral, carousel ...), where the type and number will be clarified in the pre-project:

| **Makeup position** | **Description** |
| --- | --- |
| **1 speed-loader** | * Used in Early period to retrieve batches for direct automatic loading into load carrier («Pull») * May also be used for «Push» with segregation in Late period |
| **Conventional sortation point** | * Bag are stored in sortation point until loaded automatically or manually into ULD/trolley * Used for «push» in Late period |

Tabell 4: Load cell sortation point types

The figure below illustrates the schematic layout of a load cell:

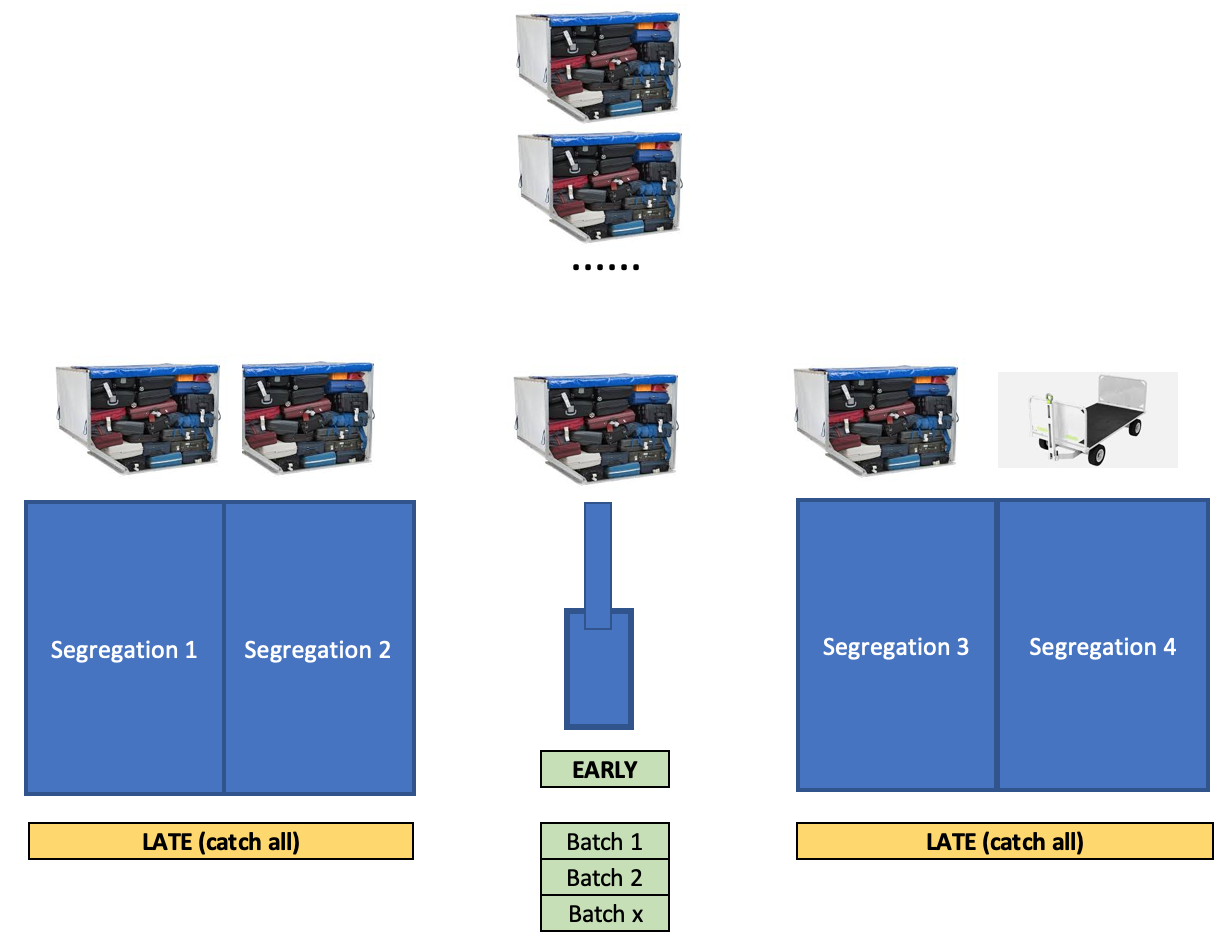


Figure 14: Load cell principles (shown with 1 speed-loader and 4 standard makeup positions)

### Intermediate storage

A batch-oriented sort has a high circulation speed in the makeup area. Hence empty load carriers must always be available when needed and full load carriers must be removed as soon as they are full.

To ensure this, space is set aside for an "intermediate storage" close to the load cells (preferably in the same building). This allows the load cell to be kept free from load carriers that are not in active use and possibly blocking internal transport in the building. The size of the intermediate storage remains to be specified.

When a load carrier has been filled in the load cell it should immediately be removed and placed in intermediate storage. Further transport will depend on whether there is free space at the aircraft stand:

* When the aircraft stand is available, the load carrier is transported to the aircraft.
* If the intermediate storage is being filled up before the aircraft stand is available, full load carriers are transported to a storage area outside the building (proximity storage).

### Proximity storage

Proximity storage is a dedicated area primarily used to store large volume of empty load carriers. The proximity storage can also be used to store full load carriers when there is no other available storage space.

Proximity storage are located as close to the makeup area as possible to reduce transport costs. The following areas have been identified for proximity storage:

* PMZ west: Area under bridge to the south pier (approx. 250 m transport distance)
* PMZ East: Area south of the fire station (approx. 850 m transport distance)

The figure below shows localization of the proximity storages for PMZ west and east respectively (in blue), as well as the typical transport route:

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Figure 16: Area for proximity storage

## Process: Baggage loading (sorting) from BHS to final sort position

For an automated load cell, the following general needs apply (to be completed and detailed):

### Functionality

* Load bags from BHS makeup positions onto load carrier
* Load bags in a space-efficient manner, providing maximum load carrier utilization
* Load bags to multiple load carriers in parallel
* Bags that cannot be loaded automatically should be diverted to a specific outlet and should not cause a stop of the automated loading
* Bags that causes jam shall not cause the entire packing process to stop for a significant time
* Possibility to shift between ULD’s and load sheets when loading and creating manifests.
* Planning and configuration tool for BHS interface

### Performance

* Handle baggage between 2-32 kg
* Handle 90+% of baggage that is classified to be within acceptable design (in size, weight, design, straps, softness etc)
* The ambition is to provide a capacity up to 400 bags/hour, today's automatic baggage packing units in the marked can handle about 200 bags/hour

### Interfaces

* Information system connectivity for monitoring and information displays through the FIDS system
* Handler user interface
* BHS interface
* BHS bagdata interface
* ULD in position
* Status and report interface
* Safety interface

## Process: Indoor transport

For automated indoor transport the following general needs apply (to be completed and detailed):

### Functionality

* Transport of loaded/empty containers
* Be able to exchange containers to and from desks, racks and other solutions (pick-up and delivery stations)
* Have safety mechanisms for coexistence with people and other vehicles in the area
* Transport booking system
* Communication system
* Charging stations

### Performance

* Carry 1000 kg
* Transport distance up to about 200m in production (on average maybe 100m), for Concept Verification the distance will be max 100m
* The number of movements is not detailed, but preliminary calculations indicate the shipping of 20 empty and 20 full containers in a busy hour within a building containing 5 load cells (we have 2 such separate buildings).

### Interfaces

* Provide interface for external control system and ordering functionality

## Process: Intermediate storage

For an automated intermediate storage rack the following general needs apply (to be completed and detailed):

### Functionality

* Be able to receive and deliver containers to indoor load carriers
* If possible, storage is allowed in 2 heights, where the available height inside the building is 4 meters
* Inventory of storage position for all load carriers
* Possibility to retrieve a specific load carrier

### Performance

* Efficient use of storage space

### Interfaces

* Provide interface for external control system and ordering functionality
* Provide statistical interface for inventory etc.

## Process: External transport

Establishing outdoor automatic transport is assumed to have a different time horizon than indoor transport, partly because it is expected that other technology is needed and that it presents greater regulatory challenges.

For automated external transport the following general needs apply (to be completed and detailed):

### Functionality

* Retrieve empty load carriers from proximity storage and deliver them to rack in intermediate storage
* Collect full load carriers from intermediate storage and deliver these to aircraft stand
* Transport one or multiple load carriers at the same time
* Have safety mechanisms for coexistence with people and other vehicles in the area

### Performance

* Transport distance up to about 1000m in production one way
* Handle the outdoor environment safely and reliably

### Interfaces

* Information system connectivity for monitoring and information displays
* Handler user interface

# Arrival First-mile bag handling

This chapter describes the departure “first-mile” bag handling processes, focusing on the potential for automation.

The main principles are described, followed by a description of processes where OSL has an ambition to automate as integrated and seamlessly as possible.

## Main principles

Arrival bags are loaded from an arrivals flight as a local arrival bag or as a transfer bag.

The responsibility for arrival bag handling is divided as follows:

* All processes from the bag is unloaded from the aircraft until the bag is loaded in the BHS are handled by the first-mile processes, where the handler has the responsibility.
* All processes from the bag is loaded into BHS and beyond are handled by the BHS system, where the airport has the responsibility.

The figure below presents a high-level overview of the baggage flow, divided into the BHS processes and the First-mile bag processes:

* The arrival makeup area is illustrated by the red box
* Dotted arrow indicates delivery of the individual bag
* Fully printed arrow indicates transport of bag on a load carrier, indicating green for empty and blue for full load carrier

**Figure 17 Arrival baggage flow**

The following sections describe the various arrival first-mile bag handling processes. Please note that the content is indicative and shall be specified in more detail.

### Arrival makeup processes

The arrival makeup processes cover the following sub-processes:

* Transporting full load carriers from aircraft to an arrival loader position
* Loading arriving and transfer bags from load carrier into BHS
* Transporting empty load carriers to a proximity storage

  
Figure 18 Arrival makeup processes

### Arrival makeup area

The arrival makeup area consists of a set of unloading positions, where bags are loaded into the BHS from load carriers.

The arrival makeup area will employ the same principles in PMZ east and west. Since PMZ east is expected to have a higher degree of container usage than PMZ west, the size and layout of the individual load cell is expected to vary and remain to be specified.

### Arrival handling principles

When a full load carrier is transported to the arrival makeup area, bags are unloaded directly into the BHS.

The current arrival makeup area has unloading stations where the handler must separate arriving and transfer bag and enter these in dedicated unloading positions.

The new BHS system will support unloading of arrival and transfer bags into the same unloading position and will thus increase efficiency as compared to the current situation.

## Process: External transport

Establishing outdoor automatic transport is assumed to have a different time horizon than indoor transport, partly because it is expected that more robust technology is needed and that it presents greater regulatory challenges.

### Functionality

* Retrieve empty load carriers from proximity storage and deliver them to aircraft stand
* Unload bulk bags from aircraft to trolleys and containers to dolly
* Transport one or more load carriers at the same time to makeup area

### Performance

* Transport distance up to about 1000 meters one way
* Provide safety mechanisms for coexistence with people and other vehicles in the area
* Handle the outdoor environment safely and reliably

### Interfaces

* Information system connectivity for monitoring and information displays
* Handler user interface

## Process: Arrival loading

Automating loading of load carriers into the BHS have as a major challenge to minimize the physical footprint, since space is limited.

### Functionality

* Unload bags from load carrier into BHS loading position

### Performance

* Gentle unloading in order to avoid bag damage
* Capacity equal or better than manual handling

### Interfaces

* Information system connectivity for monitoring and information displays through the FIDS system
* Provide statistical interface for inventory etc.
* Handler user interface