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CHOReOS Requirements and scenarios for the "Passenger-friendly airport" (D6.1)

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CHOREOS

Large Scale Choreographies
for the Future Internet

ICT IP Project

Deliverable D6.1

Requirements and scenarios for the "Passenger-friendly airport"

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Abstract

The purpose of this deliverable is to clarify the individual actions that take place among different actors of the "Passenger-friendly" scenario, as initially described in the DoW. People, services and Things interact with each other throughout the entire sequence of steps that compose the two distinct, but complementary, scenarios that support this specific use case of the CHOReOS project: "From planning to boarding" and "Bad weather at destination".

This document also provides the domain requirements that have been elicited through a detailed requirement analysis of the scenarios.

Finally, this deliverable presents a high-level overview of the choreographies that take place in the use case, for both scenarios.

Keyword list

Use Case, scenario, requirement, Airport

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Acronyms & Abbreviations

Item	Description
ATC	Air Traffic Control
BPMN	Business Process Modelling Notation
CDM	Collaborative Decision Making
DOW	Description Of Work
FI	Future Internet
QoS	Quality of Service
TBD	To Be Defined
MID	Mobile Internet Device (e.g. laptops, smartphones)
POI	Point Of Interest

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1. Introduction

This document is the product of the work performed according to Task 6.1 definition, entitled “Scenario Definition & Requirement Analysis”.

The main aim of the use case presented in this document is to illustrate the usefulness of the CHOReOS software platform for choreography support in the Future Internet, by relying on the airport domain, and its related domain-specific tasks.

More specifically, we will give in this document a comprehensive list of the **requirements** associated to the **scenarios** we develop for the “Passenger-friendly airport”. Indeed, two distinct scenarios are provided for this single use case: “From planning to boarding” and “Bad weather at destination”.

To do so requires clarifying the individual actions that take place between actors and services following a scenario-based step-by-step approach; these actions will be the building blocks of WP6 to-be-defined choreographies. A preliminary high level definition of these choreographies will be given in section 5.

1.1. Purpose

This use case takes place in the context of air transportation, which is becoming a major activity in our everyday life either for business or leisure. Air transportation has indeed proven to be particularly safe and reliable, which will remain the primary objective for all actors of a flight. **However, improvements in the services provided by air transportation are much needed**, especially when one considers capabilities brought by the networking of the various services provided by the multiple stakeholders involved.

One can consider that there are two main directions for improvements: (i) to continue optimisation of air traffic to (in particular) reduce delays, and (ii) to **better serve passengers**.

We propose to focus this use case in the latter direction where the choreography approach will prove to be an efficient means for improving services provided to passengers.

Thus, it aims to **demonstrate and assess the exploitation of choreographies in day-to-day large-scale coordination of air transportation stakeholders** (air traffic control authorities, airports, airlines...) and associated logistics partners (ground transportation, hotels, ...).

Scenario relevance with regard to CHOReOS FI context

Considering the Future Internet (FI) objectives of CHOReOS, this particular use case has several relevant illustrative characteristics, especially when considering the scalability constraints pertaining to FI. Thus, the following table give six scalability dimensions that are specific to the “Passenger-friendly airport” use case, with corresponding examples:

Scalability Dimension	Example from WP6
1. Number of service consumers	Passengers are service consumers. Depending on the number of airports and flights involved in the choreography(ies) their number varies greatly à possible congestion <i>E.g. 180,000 passengers per day at Paris – CDG airport.</i>
2. Number of service requests	Each passenger can make numerous calls to information-providing services of the airport or airline.

made by consumers	<i>E.g. 10-1000 requests/passenger from trip planning time to final boarding at gate.</i>
3. Number of services invoked in a single choreography	<p>For a choreography managing the flow of passenger at the airport level, the number of invoked services (e.g. passenger MIDs, automatic security checkpoints, orientation guides, shops, entertainment...) varies greatly according to the time of the day, vacation period, or unexpected event.</p> <p><i>E.g. from 100 to 9000+ passengers at a given time, depending on the size of the airport</i></p>
4. Frequency of service requests in time period	<p>Depending on the events (travel exceptions) and travel phases, the number of passengers making service requests (or being able to make request) varies greatly.</p> <p><i>E.g. Just before boarding a lot of passengers will simultaneously make request to airport-provided services in order to get final gate/boarding information. From 10 (small plane) to 500+ (A380) passengers boarding at the same time.</i></p>
5. Number of atomic services (actuators and sensors) aggregated in services	<p>In order to have a global monitoring of the flow of passengers in a given airport, and detect potential congestion, a (very) high number of sensors (e.g. cameras, IR sensors) need to be deployed.</p> <p><i>E.g. 100-1000+ depending on the size of the airport</i></p>
6. Change of the above dimensions over time (e.g. small crowds to large crowds)	<p>Dimensions will vary depending on the number of airports, companies, flights, passengers considered during a specific time period.</p>

1.2. Scope

This document addresses multiple 'use case'-related topics in the following sections:

- Chapter 2 deals with the definition of the first scenario related to this use case. It gives an overview description of the scenario and defines the roles of each and every actors (people, services, things) involved. This chapter also gives an abstract definition of the choreographies that coordinate all these actors.
- Chapter 3 follows the same template as Chapter 2, but applied to the second scenario of this use case.
- Chapter 4 is focused on the analysis of the domain and technical requirements linked to each scenarios, but also to system wide requirements common to both of them. This chapter also presents the method that has been used for eliciting and managing requirements in the airport context.

- Finally, Chapter 5 gives an early and high-level definition of the choreographies that manage the two scenarios of this use case, based on the descriptions given in Chapters 2 and 3. This definition relies on the BPMN¹ standard.

Moreover, requirements specified in this document will be used as primary input for deliverable D6.2 - “Passenger-friendly airport” service & choreographies design. Requirements are indeed the foundation over which services and choreographies using these services in the use case will be defined.

1.3. Related documents

Closely related documents in WP7 and WP8 are respectively **D7.1** - “Mobile-enabled coordination of people” requirements specification and use case definition, and **D8.1** - “DynaRoute” scenario specification and requirements analysis. In fact they have been purposely fashioned to follow a template and presentation that is similar to D6.1, in order to ease understanding of the use cases and present them as an unified whole.

In the same work-package as D6.1, and as it has been mentioned in the previous section, deliverable D6.2 is also directly linked to this document. Surely enough, design of services and choreographies of the “passenger-friendly” airport use-case will be based on the work laid out in this deliverable.

¹Note that, in this document, the acronym BPMN always refers to version 2.0 of the specification”

2. Scenario definition of “From planning to boarding” (scenario 1)

2.1. Overview description of scenario

This scenario describes the intricate process that any given traveller follows, when travelling by plane: from their arrival to the departure airport (by car), up to their final boarding. The backbone of this process is shown in Figure 1: it includes all the intermediary steps, mandatory or not, that the passengers follow (e.g., shopping inside the airport, or passing security checkpoints). The textual details of these steps are given in the following table.

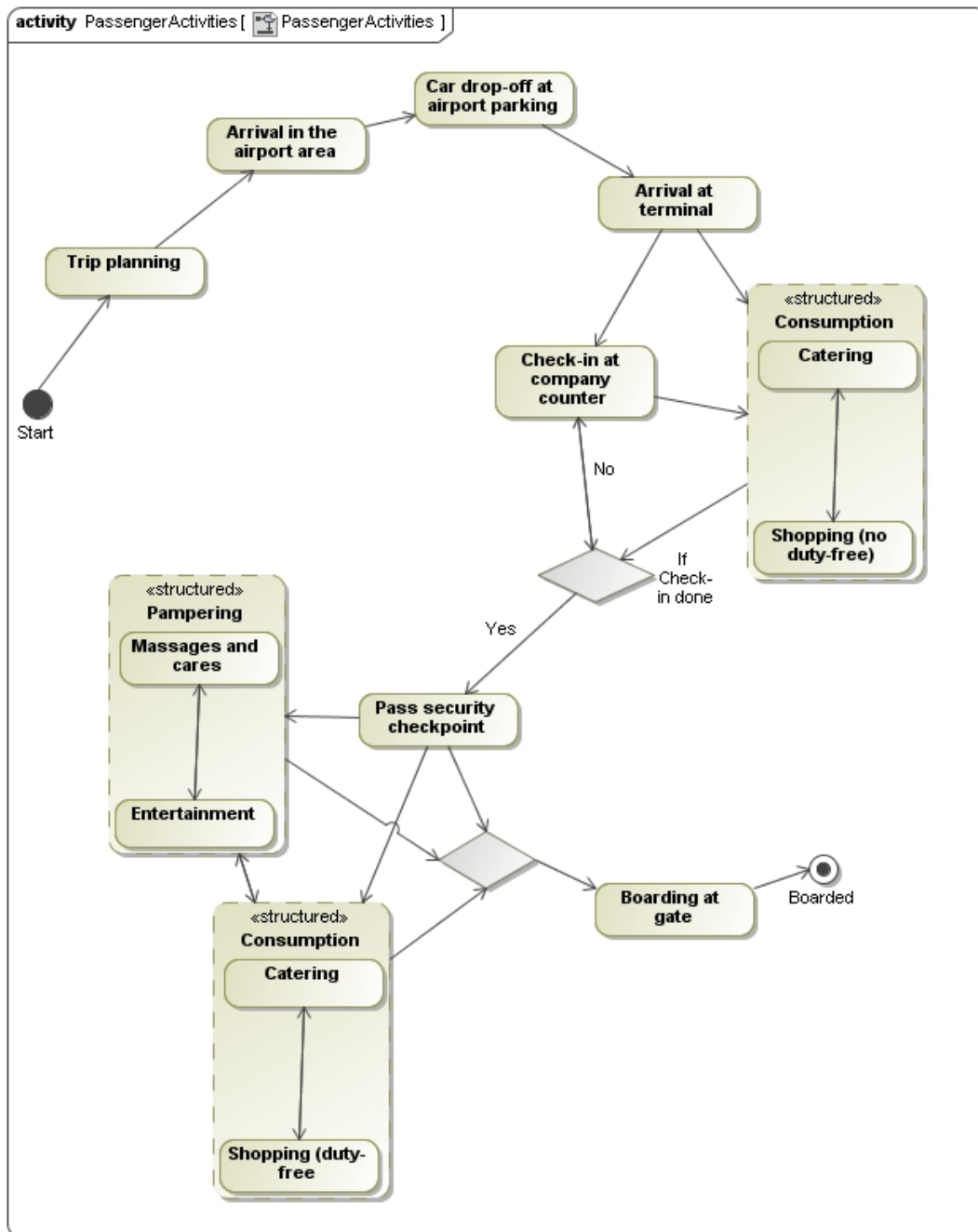


Figure 1 - Overview UML activity diagram of scenario #1

This process implies the coordination of coarse grained tasks (steps in the previous activity diagram) and of specific services provided to passengers or airport personnel: this coordination is made by choreographies. Seminal requirements of these choreographies are

detailed in Chapter 4; the choreographies themselves are represented graphically, from a high-level standpoint, in Chapter 5.

Moreover, this scenario is focused on the particular aspect of passenger “pampering” (step 8, in the following table) inside the airport, as a means to relax travellers and put them in a good buying mood. Indeed, **more than 50% of CDG Paris Airport income comes from the shops inside the terminals** (ADP sources). It has also been proven that consumption is **reversely proportional to stress level of buyers [6][7][8]**.

Also, a good way to increase passenger consumption in available shops is **to reduce queuing time at check-in counters or security checkpoints**. This scenario also deals with this particular aspect by integrating pre-check-in features available from the passenger’s home and streamlining security procedures.

Step	Description
1: Trip planning	From home or work, the passenger is able to (pre)check-in his flight on the Internet. As he will use his own car to go to the airport, he also books a car park space online.
2: Arrival in the airport area	Just before arrival at the airport, the passenger is able to check car park and terminal locations using his MID (Mobile Internet Device) thanks to an online information service provided by the airport. Upon arrival, the passenger uses this information for orientation.
3: Car drop-off at airport car park	The passenger drops his car off at the airport car park and follows the signs to the identified terminal from previous online information.
4: Arrival at terminal	Upon arrival at the terminal, the passenger wants to register for automatic security access to the checkpoints in order to gain time for this and future flights. He is also interested in catering and shopping facilities located on this side of the terminal (step 6). Finally, the passenger seeks the departure zone in the terminal public displays in order to finish check-in procedure and/or do baggage drop-off (step 5).
5: Check-in at company counter	The passenger does his check-in at the airline counter followed by baggage drop-off, if needed.
6: Consumption (Optional)	The passenger purchases goods such as newspapers and food from the shops available before the security checkpoints (no duty-free).
7: Pass security checkpoint	The passenger proceeds to security checkpoints and provides the requested ID and boarding pass for security clearance. After clearance, if he chooses to, he can go to pampering (step 8) and/or consumption (step 9) activities before catching his flight.
8: Pampering (Optional)	Once the security checkpoints have been crossed, the passenger is able (provided he has enough time remaining before boarding his flight) to use pampering facilities provided by the airport (e.g. massages and cares, entertainment). Following pampering, he can move on to the shops and

	catering facilities available in the duty free zone (step 9), or directly board his plane if time has come (step 10).
9: Consumption (Optional)	In the zone beyond the security checkpoint the passenger can either access to duty free shops or catering facilities. He can freely go back and forth between pampering (step 8) and consumption activities (and this particular aspect is to be encouraged by the scenario)
10: Boarding at gate	The passenger needs to proceed to his identified boarding gate. This information can be found on his boarding pass, but also on public displays or via online flight information.
End (Boarded)	On call of his seat row range, the passenger is invited to come to the boarding desk in order to get on the plane after a last check of his ID and boarding pass.

Table 1 - Individual steps of the “From planning to boarding” scenario

2.2. The “From planning to boarding” scenario

In the following sub-sections we give details over the main characteristics of the actors involved in this scenario. These actors can either be *People*, *Services* or *Things*.

2.2.1. People

In the scenario, people are the end users of services and things coordinated by choreographed.

- **Passengers:** they are the main actors of the choreographies since they deal with all the steps they must follow from planning to boarding a plane. Moreover, MIDs are their main mean of interaction with other services and things of the scenario. Finally, for each choreography step dealing with passengers, a single or small group of passengers (e.g., a family) performing the same action (i.e., the name of the step) is considered.
- **Security agents:** their main responsibility is to deal with passengers at security checkpoints. They have to check, among other identification documents, passengers’ paperless boarding passes displayed on their MIDs.

2.2.2. Services

These services accept predefined parameters as inputs (such as passengers unique IDs), and output functional (i.e., return values) and non-functional information (i.e., QoS). From the passengers point of view, their MIDs is their main presentation media for the result that these services provide.

- **Airline flight check-in:** provide check-in and pre-check-in services to passengers; from home when planning their flights, as well as in the airport to deliver paper-less boarding passes.
- **Airport car park reservation:** used by passengers to make car park reservations before leaving their home, but also used upon arrival at the terminal to retrieve last-minute assigned car park information.
- **Traffic info:** used by passengers before leaving home and during transportation to the airport in order to retrieve traffic information.
- **Flight info:** used to retrieve all flight-related information such as departure time, terminal, assigned gate, delays, etc.
- **Airport access and orientation interactive guide:** used to compute and retrieve directions inside the airport terminals.

- **Airport monitoring:** used to access current information on airport congestion. For instance, this can impact direction computations made by the *Airport access and orientation interactive guide* service, in order to optimize the flow of passengers inside the terminals.
- **Security Reservation:** used by security reservation kiosk and security agents to check credentials of passengers that want to register for automatic security access upon arrival in the terminal.
- **Consumption services:** these services relate to the catering and shopping facilities that are available inside the airport terminal. Passengers will be provided with information about these facilities through these services; information that will be displayed on their MIDs. Purchase transactions of foods and goods will also be made through these services. Services decompose into:
 - **Catering:** service dedicated to catering
 - **Shopping:** service dedicated to shopping
- **Airline:** service used to retrieve all airline-related information. It is also used to check coupon availability for a given passenger by airline partners (consumption services from the airport).
- **Airport:** service that represents the local airport authority and that is responsible for managing other partners in the terminals, such as the security company (e.g., it deals with allocating *security agents* to specific check-points depending on arrival and departures)
- **Security company:** service that represents the security company that manages all the *security agents*.
- **Pampering services:** these services (free or not) are part of the global strategy of the airport authority to pamper passenger in order to deliver a better travelling experience and increase passenger purchases inside the terminals. They are divided in multiple sub-categories:
 - Entertainment:
 - Video Game,
 - VOD,
 - Digital corner (wifi/internet),
 - Playground.
 - Massage and cares

2.2.3. Things

- **MIDs:** these are the Mobile Internet Devices that passengers use to access services available to them and display information at various steps of the scenario. Smartphones are the best example of always available MID, with mobile Internet connection, that is already pervasive in our environment and can be used to access these services. In this scenario it is also used as a paperless boarding pass.
- **Security reservation kiosks:** used by passengers and security agents to register passengers for automatic security access.
- **Terminal public displays:** used by airlines and airport to display information related to arrivals, departures, as well as gate assignments.
- **Terminal check-in points:** dispatched across the airport terminals, grouped by airline companies, in order to ease passenger check-in process and passenger flow. Indeed,

using these points, passenger can obtain easily a boarding pass without going to the airline counter; but only if they don't have any baggage to drop-off.

- **Airline counter:** used for passenger check-in process, including boarding pass delivery and baggage drop-off.
- **Security Automatic Gate:** like *terminal check-in points*, are used to ease passenger flow in the terminals. If passengers are registered for automatic security access, they can go through these gates, thus avoiding the hurdle of classic security checks requiring a dedicated security agent and long waiting lines.

3. Scenario definition of “Bad weather at destination” (scenario 2)

3.1. Overview description of scenario

This scenario describes the various consequences that arise from rerouting airplanes due to bad weather at their destination airport. In that case, a reroute request is emitted for every flight currently reaching this airport and multiple well-known steps must be followed in order to find an alternative destination airport, keep passengers informed, as well as prepare for their unexpected arrival at the new airport. These are the steps that are described in the process shown in Figure 2. As for scenario 1, the textual details of these steps are given in Table 2.

It is to be noted that all the steps in the figure and table are **focused on one specific flight**, which means that each and every one of them need to be independently followed **for every flight** impacted by the rerouting requests.

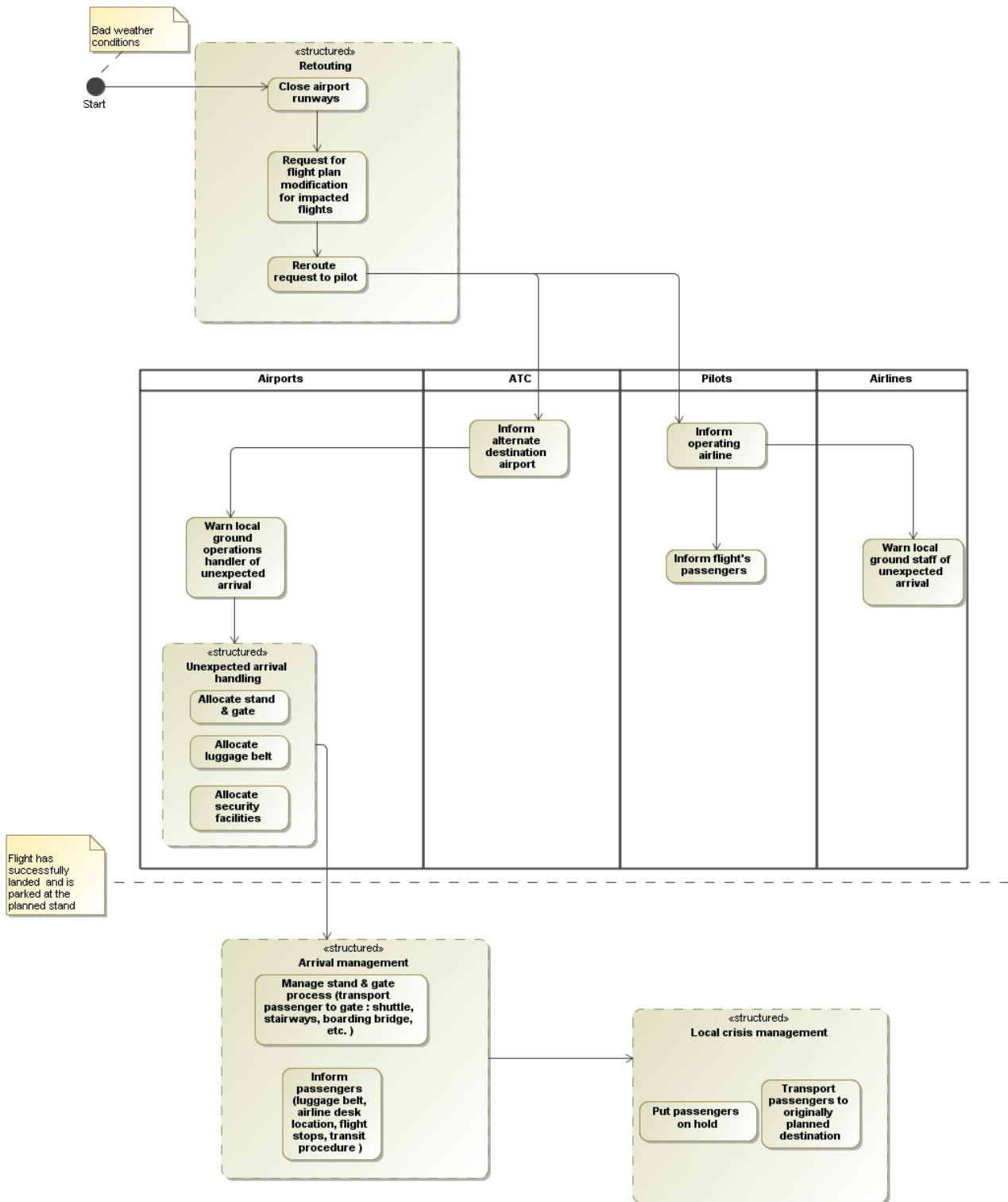


Figure 2 - Overview UML activity diagram of scenario #2

Step	Description
Start	An airport is facing bad weather conditions (heavy snow) and reports from weather stations are forecasting poorer weather to come.
1: Rerouting	A decision is made to close all airport runways and flight plans for all scheduled flights need to be modified accordingly (step 2). Airport ATC communicates with pilots for reroute request.

Step	Description
2: Flight plan modification	Once agreement is found on the final destination between ATC and the pilot: <ol style="list-style-type: none"> 1. The pilot informs his airline of the flight plan modification and gives new information to his passengers. 2. The alternate destination airport is informed of flight plan modification by ATC.
3: Unexpected arrival warning	The local destination Airport authority warns ground operations handlers (Airport Bus company, Luggage Handling company, Security company, etc.) of the unexpected arrival. The Airline informs warns its own local ground staff (at destination) of the arrival at their airport.
4: Unexpected arrival handling	The local destination Airport authority manages stand and gate, luggage belt and customs and security allocation, in anticipation of unexpected arrival.
5: Arrival management	The local destination Airport authority puts into place stand and gate management (to transport passengers by bus to gate if needed, etc.) and provides information to passengers such as luggage belt location.
6: Local crisis management	The Airline ground staff makes a decision between putting the passengers on hold (for the night) until the weather conditions are restored, or directly transporting the passengers to the originally planned destination (using new flight, bus and/or rail).

Table 2 - Individual steps of the “Bad weather at destination” scenario

3.2. The “Bad weather at destination” scenario

In the following sub-sections we give details over the main characteristics of the actors involved in this scenario. These actors can either be *People*, *Services* or *Things*.

3.2.1. People

- **Pilot:** the pilot is the one commanding a specific plane being rerouted.
- **Passengers:** from the perspective of a particular step of this scenario, passengers are the group of people contained in a specific plane that is being rerouted. They are treated as a single indivisible group of people and not independently.
- **Airline Ground Staff:** the alternative airport staff pertaining to the company of a specific plane being rerouted.
- **Security Agents:** deal with any security procedure the passengers are subjected to upon arrival at the alternative airport.
- **Luggage Handler:** alternative airport staff that has the responsibility of dealing with passengers baggage upon arrival at the alternative airport.

3.2.2. Services

Some of these services, and their descriptions, are shared with the previous scenario.

- **Airport:** service that represents the local airport authority and that is responsible for managing other partners in the terminals, such as the security company (e.g. it deals with allocating *security agents* to specific check-points depending on arrival and departures)
- **ATC (Airport Traffic Control):** service that represents the authority that deals with airplane flight management and, in the specific case of this scenario, that manages the rerouting of airplanes by informing pilots and airports.
- **Airline:** service used to retrieve all airline-related information and also inform airlines of airplanes rerouting.
- **Security Company:** service that represents the security company that manages all the *security agents*.
- **Airport Bus Company:** service that represents the company that manages all ground transportation by bus inside the airport perimeter (e.g. plane-to-gate and gate-to-plane operations).
- **Luggage Handling Company:** service that represents the company that manage all *luggage handlers* and assign them to the correct plane and/or luggage belt.
- **Weather forecast:** service used by *ATC* and *airport ground staff* to obtain weather forecasts.
- **Travel Agency:** service that represents the travel agency of a passenger. Used for communication with this travel agency.
- **Hotel:** service that represents the hotel where a passenger is assigned for the night. Used for communication with this hotel.
- **Ground Transportation Service:** service that represents the company that manages all ground transportation by bus outside the airport perimeter (e.g. to move passengers to their hotels).
- **Airport runway:** service that represents the runway managed by the airport and that need to be closed due to bad weather.

3.2.3. Things

- **MIDs:** these are the Mobile Internet Devices that passengers use to access services available to them and display information at various steps of the scenario
- **Terminal public displays:** used by airlines and airport to display information related to arrivals, departures, as well as gate assignments.

4. Requirements analysis

A detailed requirements analysis was used to identify the specifications and needed functionality of services and choreographies for the “Passenger-friendly airport” use case. The requirements specification addresses both functional and non-functional concerns for the assessment of the solutions developed as part of the CHOReOS IDRE.

4.1. Method for eliciting and managing requirements

The requirements process for CHOReOS was devised to elicit high level requirements using a structured scenario-based approach. Using the scenario as a means of requirements elicitation enables the requirements analyst to ground questions in context through the sequence of events in the scenario. The process was facilitated in two separate, but complementary, exercises by analysts from City University London and Thales.

A research visit to Southampton Airport was arranged and took place on 17th November 2010. It involved one researcher from the CHOReOS project and two students from City University London. The visit included access to Air Traffic Control (ATC) and areas common to the general travelling public. The purpose of the visit was to explore possible uses of services in passenger-friendly airports and to envisage how services can enhance passenger experiences. The steps of the passenger journey scenario ‘from planning to boarding’, specified in Table 1, were considered during the visit. The scope was to examine and document what information was available at Southampton Airport, but also to discover new ideas for the “passenger-friendly” airport use case. The ‘bad weather at destination’ scenario, specified in Table 2, was described and discussed with the control tower manager, Andrew Kenyon from NATS, and two air traffic controllers.

The information captured from the research visit was organised using the steps in both scenarios and used by the City University analyst to elicit requirements. Meanwhile, the Thales analyst consulted internal stakeholders with air traffic domain expertise and accessed Thales documentation to follow the same procedure of eliciting requirements from the scenario steps. These scenario-bound requirements are detailed in Sections 4.3 and 4.4, as well as system-wide requirements in Table 4. The requirements were framed using a taxonomy of requirements common to the *DynaRoute*, *Large Scale Brainstorming* and “Passenger-friendly” Airport use cases. Taxonomies of requirements are used to improve understanding, analysis and testing of the solution, and are therefore used during requirements elicitation to write clearer more focused requirements. The types, along with example requirements, are presented in the table below.

Service consumer requirements		
Functional [FR]:	Something (service, behavior, function) that a product must do	e.g. a service only supports authenticated consumers
Performance [PR]:	The desired times and/or throughput rates that an actor should be able to undertake	e.g. the passenger shall be able to check-in in less than 5 min
Availability [AvR]:	The minimum required levels of access that stakeholders have to MICE and related work activities	e.g. the passenger shall be able to access flight departure information at all times

Accuracy [AcR]:	The error rate produced by the service calculated on the basis of the expected results.	e.g. the estimated boarding time of a flight shall be accurate to the minute
Security (& privacy and trust) [SR]:	The minimum levels of security that a passenger and related work activities should be exposed to	e.g. the passenger shall provide authentication in order to access their user profile details
Service developer (system) requirements		
Scalability [ScR]:	The capability and system's ability to process more users' requests, operations or transactions in a given time interval.	e.g. airport services shall be able to deal with huge variation in volume of passengers requests depending on travel exceptions
Interoperability [IR]:	The ability of a software component to interact with other components or systems.	e.g. the MID of a passenger shall be able to interact with multiple service of different types
Awareness [AwR] & Adaptability [AdR]:	The level of awareness and predictability of upcoming changes & the ability of the system to change to new specifications or operating environments	e.g. the airport access and orientation interactive guide should adapt its answers according to current airport congestion
Reliability [RR]:	The minimum levels of failure that specific product/services should demonstrate	e.g. a critical airport service shall achieve 99% up-time

Table 3 - Requirements taxonomy for the CHOReOS use cases

4.2. System wide requirements

System-wide requirements are the high-level requirements that express desirable properties **of the system** as a whole. The following requirements were captured by following the scenario-based approach:

ID	Name	Description
Functional		
FR001	BPMN 2.0 support	BPMN2.0 paradigms that allow the definition of elaborated and nested choreographies are needed in the Airport UC, due to its complexity. Moreover, from an industrial standpoint, the BPMN 2.0 specification is well known and supported by OW2

ID	Name	Description
FR002	BPMN 1.x support	BPMN 2.0 is quite new and already existing BPMN 1.x choreographies from Airport Authorities and actors, if they exist, SHOULD be integrated in the system.
FR003	Runtime monitoring of choreographies	The system SHALL support the monitoring of enacted choreographies at runtime, particularly according to non-functional characteristics specific to this UC.
FR004	Remote surveillance of choreography	Any running choreography SHALL be monitored and controlled from remote client position.
FR005	Traceability	The system SHOULD log all service calls and their status changes with time and unique ID (per choreography).
FR006	MID as boarding pass capability	The MID SHALL be able to display a fully functioning boarding pass.
FR007	Passenger preference definition	The passenger SHALL be able to express their preferences using a user profile.
FR008	MID adaptation to passenger preferences and behaviours	The MID SHALL update the user profile based on stated preferences and behaviours from the passenger over time
FR009	MID reminder capability	The passenger SHALL receive reminders from the MID at each key stage of the process [e.g. passport reminder, go to gate message]
FR010	MID friend tracking capability	The passenger SHALL be able to track friends and colleagues in the airport using their MIDs and location based services
FR011	MID audio features	The MID SHALL be able to guide the passenger using audio features
FR012	MID service history recording feature	The MID SHALL provide the passenger with an ordered list of services that they most commonly use [e.g. sequence an itinerary based on common behaviour]
FR013	MID event plan update capability	The MID SHALL automatically update a passenger event plan based on the current flight status
Performance		
PR001	Flight status updates	The passenger SHALL be informed of any changes to their flight status within 3 seconds of the information being available

ID	Name	Description
Security		
SR001	Confidentiality	Interactions between service consumers and providers SHALL be secured to guarantee confidentiality of exchanged sensible data.
SR002	Dynamic access control to services	In case of emergency, services SHOULD have their access control relaxed to authorize temporary consumption.
SR003	Dynamic access control to passenger data	In order to personalize services provided to the passenger, access to travel data SHALL be granted to applications/operators according to circumstances. Modification of access rights, if any, SHALL be temporary and attached to the context.
SR004	Circle of trust	Organisations collaborating within the UC SHALL share user identities or system identities to grant access to their services and data (No central identity management).
SR005	Integrity	Exchanges between organisations SHALL be secured to avoid any corruption of data.
Scalability		
ScR001	Ultra Large Scale (ULS) choreography supports	Due to its large list of actors (ATC, Airline, Airport entities, passengers), the system MUST have encompassing ULS choreography support: indeed, the number of invoked services in a choreography (e.g. passenger MIDs, automatic security checkpoints, orientation guides, shops, entertainment...) varies greatly according to the time of the day, vacation period, or unexpected event.
ScR002	Service request scalability	The system MUST be able to deal with huge variations in number of service requests over time.
ScR003	Number of atomic services (accentuators and sensors) aggregated in services scalability	In order to have a global monitoring of the flow of passengers in a given airport, and detect potential congestion, a (very) high number of sensors (e.g. cameras, IR sensors) need to be deployed and supported by the system and running choreographies.
Interoperability		
IR001	MID interoperability	A passenger's MID SHALL be able to transparently access services of different types, technologies, and provided by different

ID	Name	Description
		entities (e.g. airport, airline, ...)
IR002	Dynamic service discovery	In this UC, a flight can be rerouted and critical services from new destination infrastructures need to be discovered since they differ from the original destination. As such, the system MUST support the dynamic discovery of services during the enactment of choreographies.
IR003	Human interaction	Choreography MUST allow for human interaction in the loop in order to apply modifications at runtime.
IR004	Runtime flexibility	The coordination of all services in the system SHALL be highly flexible due the heterogeneity of involved services.
IR005	MID to MID interoperability	The passenger SHALL be able to transfer information views from one MID to another
Reliability		
RR001	Message queuing	Exchanges between organisations SHALL be performed in a secured way so that interactions may recover from temporary unavailability of services
RR002	Runtime Distributivity	Since there MUST NOT be any single point of control or failure in a choreography (especially critical airport regulation ones), the responsibility of the execution MUST be distributed through all its participants.

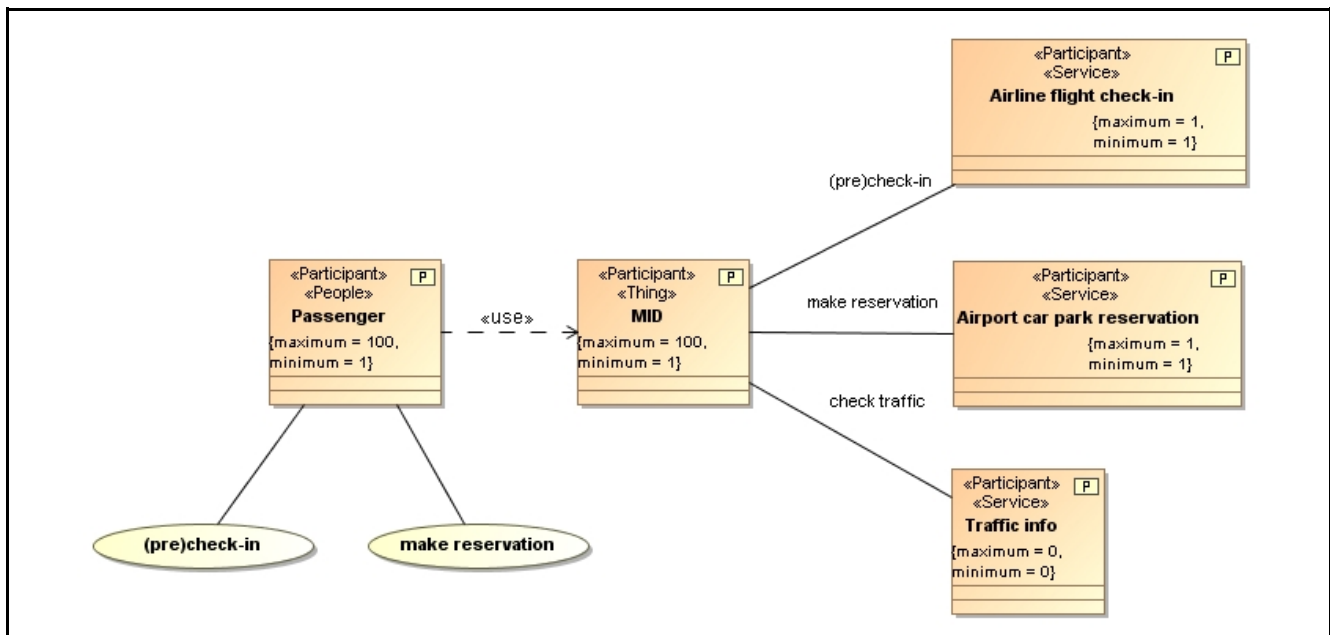
Table 4 - System-wide requirements

4.3. Step-level requirements for scenario “From planning to boarding”

Step-level requirements are the more detailed requirements that relate to the individual steps in the scenario. The following requirements were captured by stepping through the scenario and were categorized in three different types (with corresponding symbols):

No symbol	Requirement specific to scenario step (action)
*	Requirement shared by more than one scenario step
+	System-wide requirement that can be verified at the step-specific level

1: Trip planning



- + SR001 - Confidentiality
- + SR003 - Dynamic access control to passenger data
- + SR004 - Circle of trust
- + IR001 - MID interoperability
- + IR003 - Human interaction

- SC1-FR014 - Passenger authentication - The 'Airline flight check-in' service SHALL only support authenticated consumers
- SC1-FR015 - Multi-criteria flight query - The 'Airline flight check-in' service shall support multi-criteria flight query
- SC1-FR016 - Driver authentication - The 'Airport car park reservation' service SHALL only support authenticated consumers
- SC1-FR017 - Multi-criteria reservation request - The 'Airport car park reservation' service shall support multi-criteria reservation requests
- SC1-FR018 - Reservation (and check-in) traceability - The passenger is SHALL be able, at any-time, to access the status of his reservations using his MID
- SC1-FR019 - Check-in opening time - The passenger SHALL be informed of check-in opening time when they (pre)check-in
- SC1-FR020 - Luggage restrictions information - The passenger SHALL be informed of luggage restrictions when they (pre)check-in
[e.g. maximum luggage weight, banned items, hand luggage restrictions]
- SC1-FR021 - MID checklist support - The MID SHALL provide the passenger with checklist reminders of essential items to take to the airport
[e.g. passport, identity card, currency etc.]
- SC1-FR022 - MID weather information - The MID SHALL provide up-to-date weather conditions at the destination prior to the passenger leaving home [e.g. In order for them to pack the appropriate clothing]
- SC1-FR023 (depends on FR008) - Parking selection - The passenger SHALL be able to select his parking based on a set of preference criteria [e.g. availability, location, parking space size and price]
- SC1-FR024 - Car park to terminal travel time information - The passenger SHALL be aware of the travel time from the car park to the terminal
- SC1-FR025 - Car park to terminal transport link information - The passenger SHALL be provided with transport link information between car park and the terminal
- SC1-FR026 - Live traffic information and planning - The passenger SHALL be provided

with live traffic information and route planning prior to arrival at the airport. [e.g. Travel times, traffic jams, diversions etc.]

SC1-FR027 - On-board meals and entertainment information - The passenger SHALL be able to review the schedule for on-board meals and entertainment after online check-in

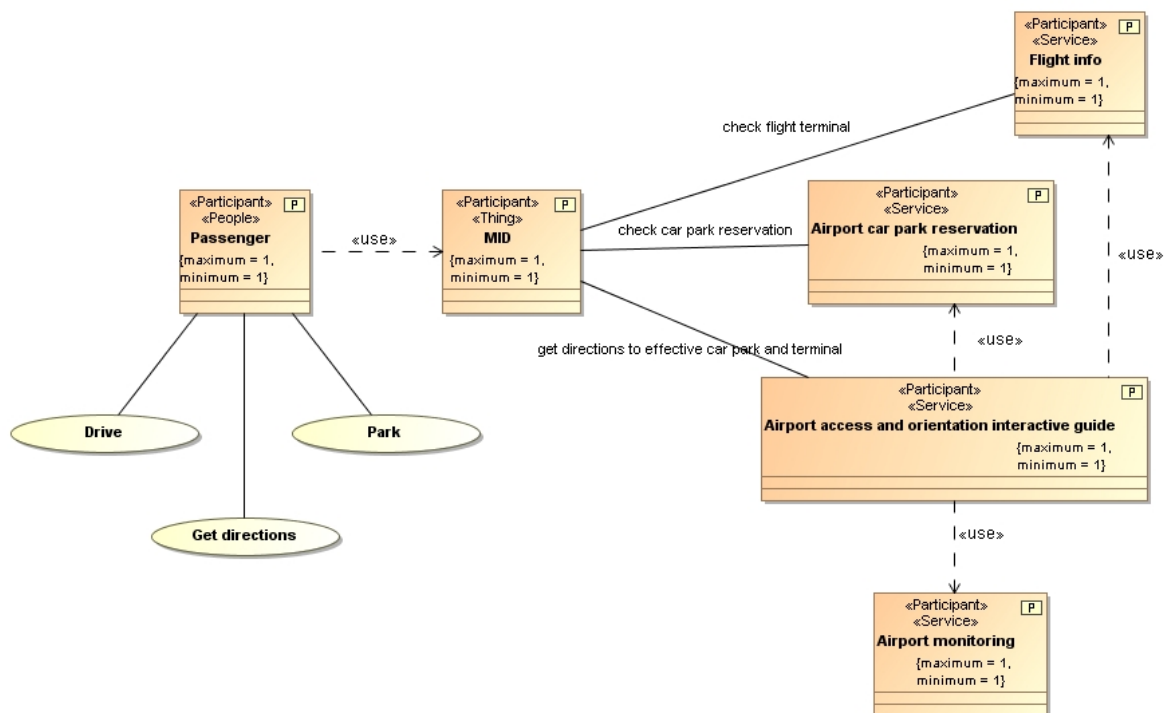
SC1-SR006 - Passenger authentication - The passenger MUST authenticate itself for pre-check-in

SC1-SR007 (based on SR004) - Exchange of passenger data - The 'Airline flight check-in' and 'Airport car park reservation' services MIGHT be able to exchange passenger data when needed

SC1-ScR004 - Time-frame scalability - The 'Airline flight check-in' SHALL be able to deal with all flights made available by the airline over a given period of 1 week to 2 months, according to airline internal policies.

SC1-ScR005 - Punctual scalability - The 'Airline flight check-in' SHALL be able to deal with seasonal variations of flights numbers, in order to deal with passenger increases (e.g. during vacation times, or specific events like World Cups).

2: Arrival at airport



- + SR001 - Confidentiality
- + SR003 - Dynamic access control to passenger data
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR001 - MID interoperability
- + IR003 - Human interaction
- + FR009 - MID reminder capability

SC1-SR008 (based on SR005) - Coherence of reservation numbers - Reservation number

used upon arrival at the airport for car park reservation SHOULD be coherent with services back-ends and unique.

* SC1-FR028 - MID geolocation - MID SHALL provide geolocation information (e.g. for itinerary computation)

* SC1-FR029 - POI retrieval - 'Airport access and orientation interactive guide' service SHALL be able to answer passengers POI requests and provide multiple alternative answers if available

* SC1-FR030 (depends on FR008) - Alternate route computation - 'Airport access and orientation interactive guide' service SHALL be able to provide alternate routes to reach a given POI, according to airport congestion and user preferences (e.g. reduced mobility passenger)

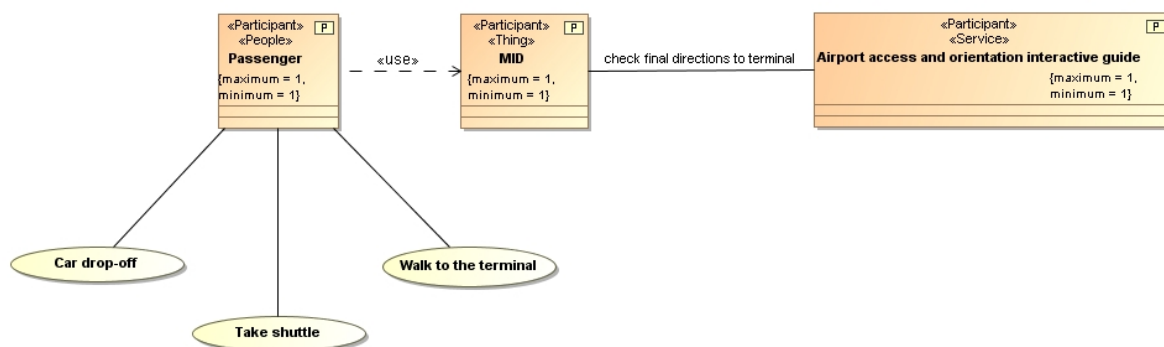
SC1-FR031 - MID car park orientation by audio - The MID SHALL provide car park orientation information via audio [The passenger may be driving and unable to view their MID display].

SC1-AcR001 - Geolocation accuracy - Precision of geolocation SHOULD be comprised between 5 and 100 meters

SC1-PR002 - 'Airport access and orientation interactive guide' performance - The 'Airport access and orientation interactive guide' SHOULD provide directions to effective car park and terminal under 30 seconds

SC1-AwR001 - Adaptation to airport congestion - The 'Airport access and orientation interactive guide' SHOULD adapt its answers according to current airport congestion

3: Car drop-off at airport car park



+ SR003 - Dynamic access control to passenger data

+ IR001 - MID interoperability

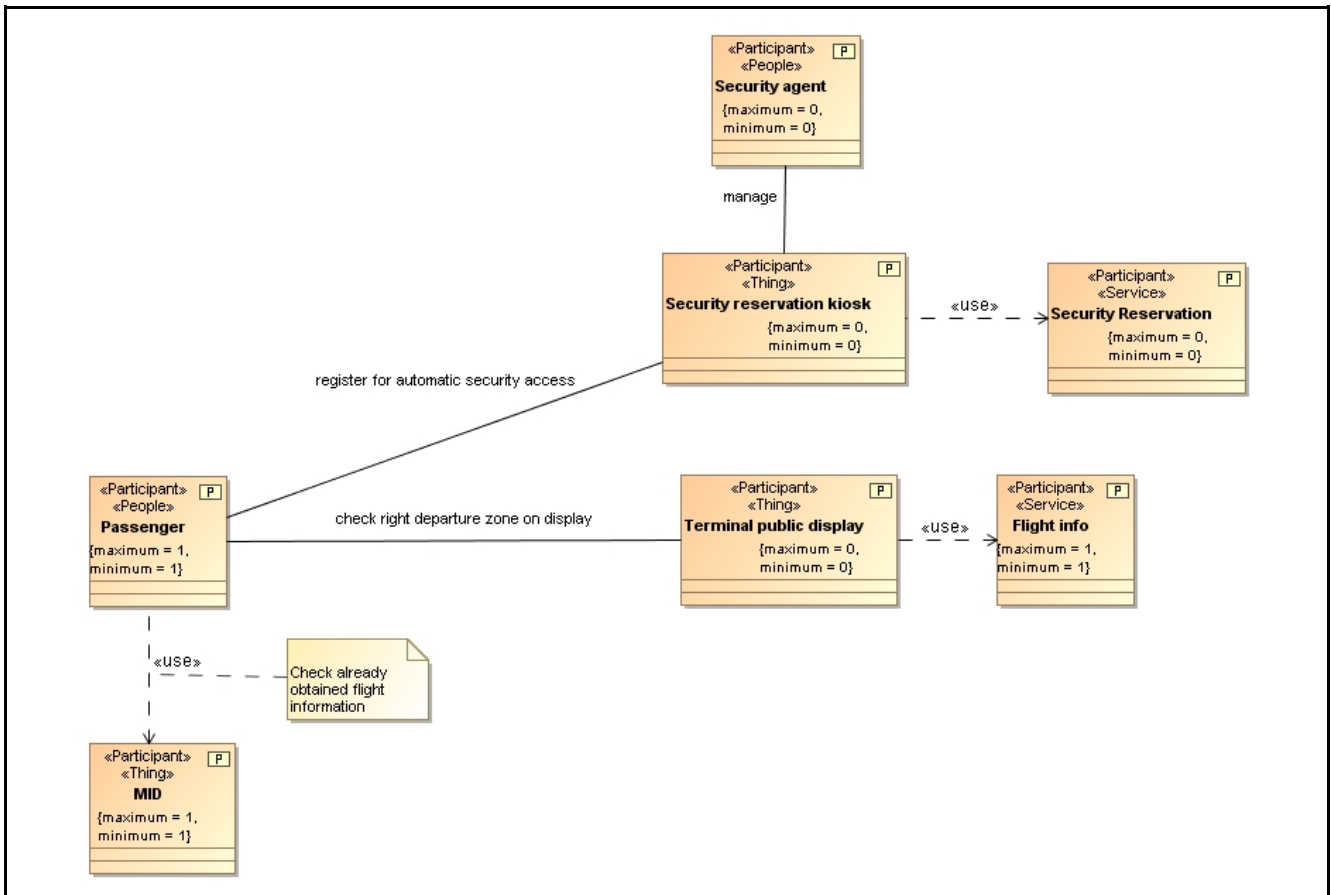
+ IR003 - Human interaction

+ FR009 - MID reminder capability

SC1-FR032 - Nearest trolley information - The passenger SHALL be made aware of the nearest luggage trolley stand

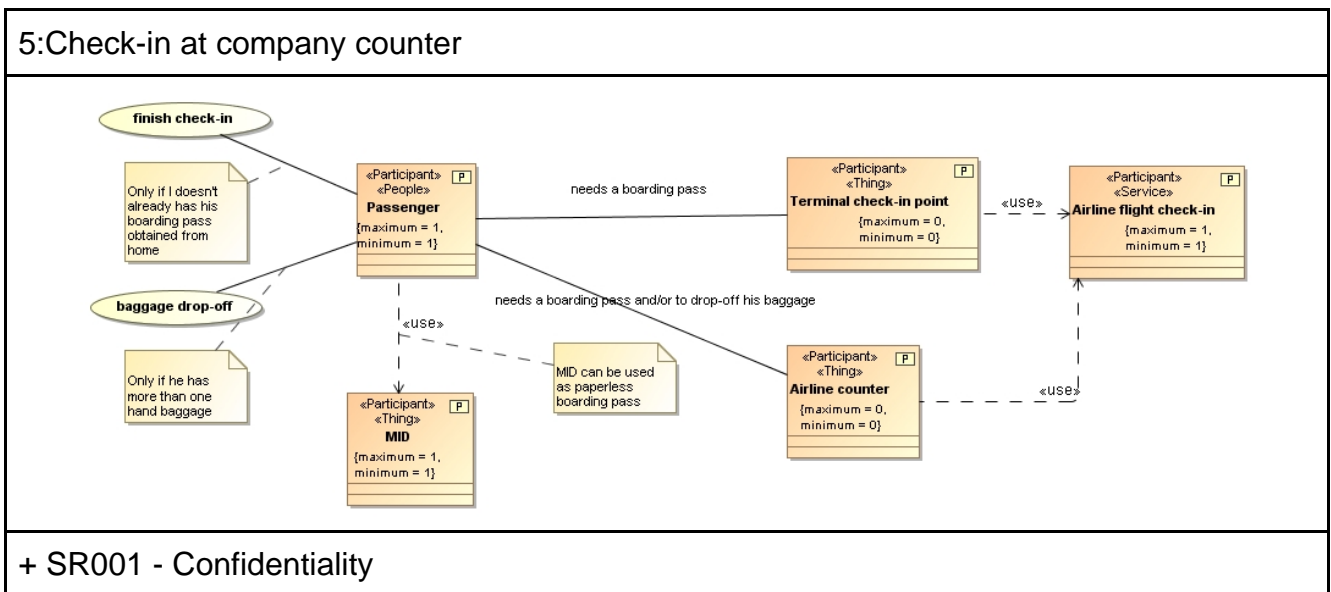
SC1-FR033 - Car park to terminal transport real-time information - The passenger SHALL be provided with real-time information for transport links between the car park and the terminal

4: Arrival at terminal



- + SR001 - Confidentiality
- + IR003 - Human interaction
- + SR005 - Integrity
- + FR009 - MID reminder capability

SC1-SR009 (based on SR005) - Secured flight information - Flights information SHOULD be provided to the Terminal public displays in a secured manner to ensure data integrity.
 SC1-SR010 (based on SR001) - Security agent/reservation kiosk confidentiality - Due to the sensible nature of data exchanged between the passenger and the security agent/reservation kiosk, all exchanges must remain confidential.



- + SR001 - Confidentiality

- + SR003 - Dynamic access control to passenger data
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR001 - MID interoperability
- + IR003 - Human interaction
- + FR006 - MID as boarding pass capability
- + FR009 - MID reminder capability

SC1-FR034 - Deal with scheduled passengers - The 'Airline flight check-in' service SHALL be able to deal with all passengers scheduled on a given flight operated by this airline

SC1-FR035 - Deal with rescheduled passengers - The 'Airline flight check-in' service SHALL be able to deal with passengers that were not originally scheduled for a given flight, but need to be rescheduled due to e.g. cancelled or missed flight of the same (or partner) airline

SC1-FR036 - MID check-in directions - The passenger SHALL be directed to the correct check-in and bag drop location via their MID

SC1-FR037 - Assistance request - The passenger SHALL be able to request late arrival assistance based on their flight number [e.g. fast track through check-in process]

SC1-AwR002 - Passenger density at check-in awareness - The passenger SHALL be made aware of the quickest check-in option and location based on current passenger density information

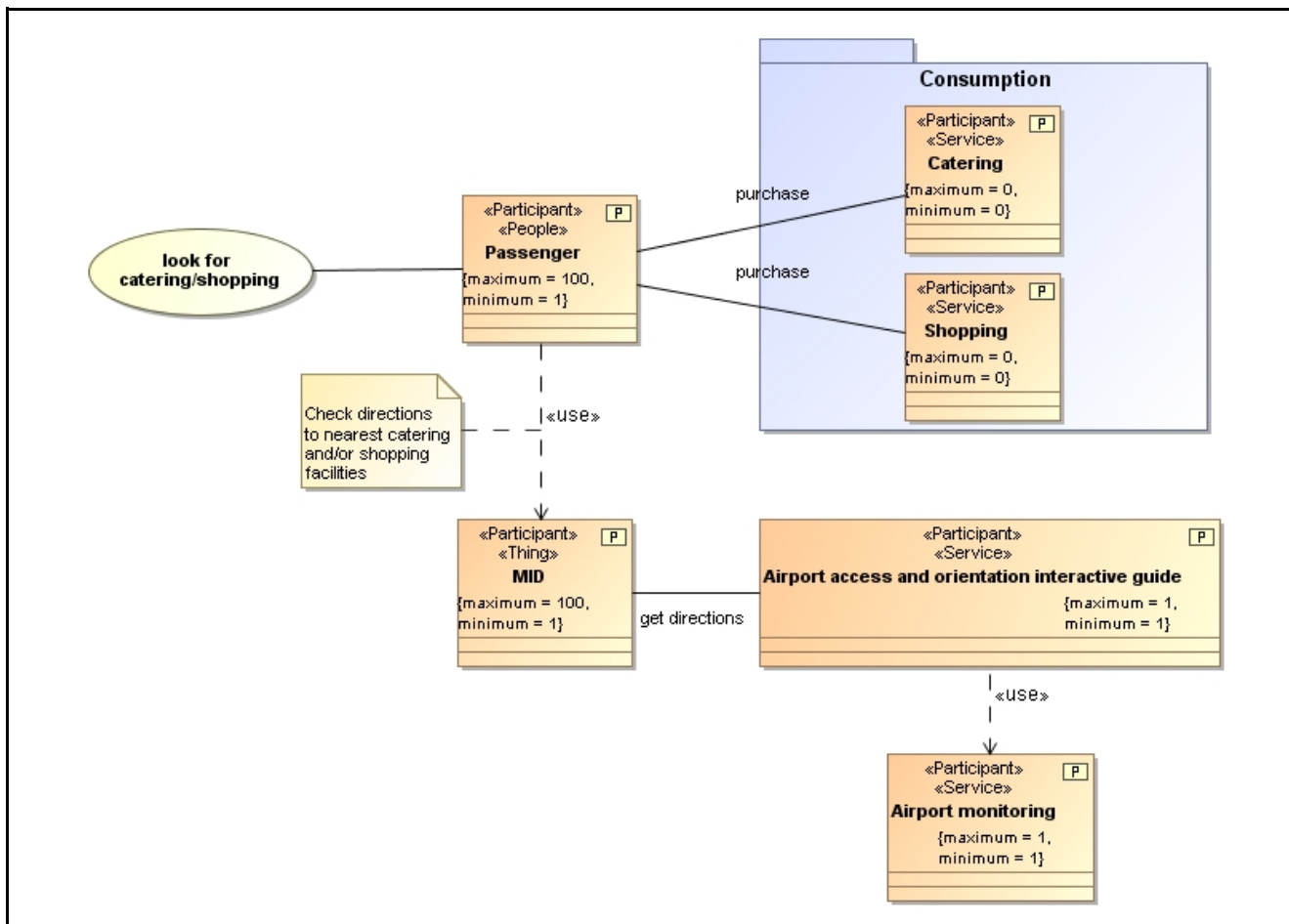
SC1-ScR006 - Scale to daily flightboard - The 'Airline flight check-in' service shall be able to deal with all flights departures operated by the airline over a given exploitation day.

SC1-PR003 - Check-in performance - The global check-in process SHALL be done in less than 5 min per passenger

SC1-PR004 - Check-in closure performance - The global check-in process SHALL be closed 45 min before boarding

SC1-SR011 (based on SR004) - Airlines partnership - Partner airlines SHOULD share flights and passengers data on specific cases (e.g. codeshare flights, passenger forwarding between airlines,...)

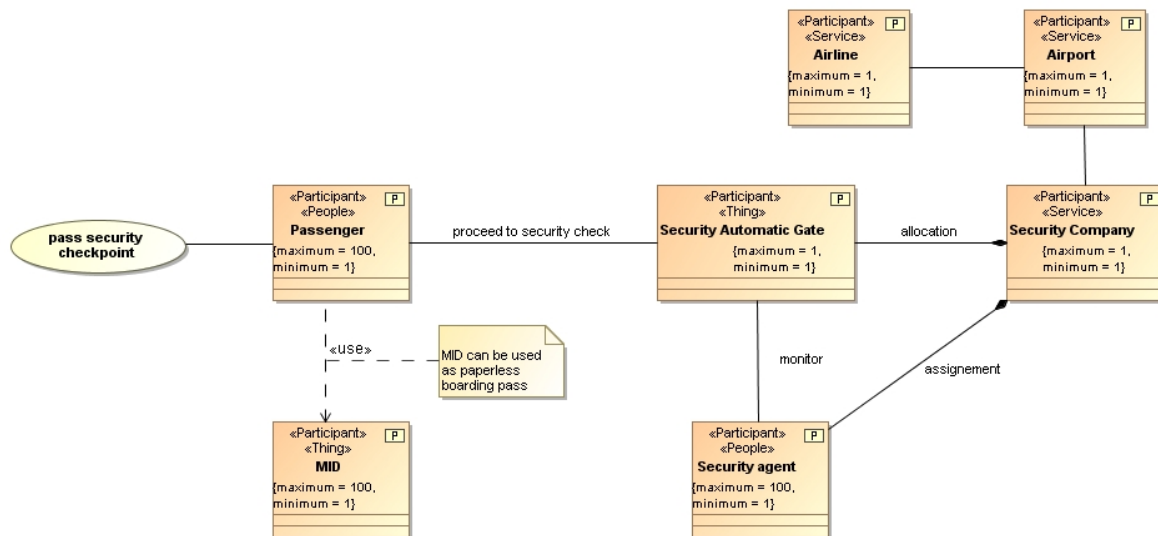
6: Consumption (Optional)



- + SR001 - Confidentiality
- + SR003 - Dynamic access control to passenger data
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR001 - MID interoperability
- + IR003 - Human interaction

- * SC1-FR028 - MID geolocation - MID SHALL provide geolocation information (e.g. for itinerary computation)
- * SC1-FR029 - POI retrieval - 'Airport access and orientation interactive guide' service SHALL be able to answer passengers POI requests and provide multiple alternative answers if available
- * SC1-FR030 (depends on FR008) - Alternate route computation - 'Airport access and orientation interactive guide' service SHALL be able to provide alternate routes to reach a given POI, according to airport congestion and user preferences (e.g. reduced mobility passenger)
- SC1-FR038 - MID product recognition capabilities - The MID SHALL have product recognition capabilities
- SC1-FR039 - MID currency conversion feature - The passenger SHALL be able to view prices in their own currency using their MID
- SC1-FR040 - MID product price comparison feature - The passenger SHALL be able to compare prices of similar products within the airport, online and in their local shops using their MID [e.g. this may include comparisons between products before and after the security checkpoint]

7: Pass security checkpoint



- + SR001 - Confidentiality
- + SR003 - Dynamic access control to passenger data
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR001 - MID interoperability
- + IR003 - Human interaction
- + FR006 - MID as boarding pass capability
- + FR009 - MID reminder capability

SC1-AwR003 - Automatic Gates provision - For a specific time period, the amount of automatic gates implemented (and associated security agent reserved) SHOULD match the planned amount of passenger with automatic security clearance expected

SC1-SR012 (based on SR004) - Security facilities forecast - Airlines, Airport and Security Company SHALL be able to exchange passenger information in order to provision security facilities on a given exploitation day

SC1-FR041 - Security clearance delay information - The passenger SHALL be kept up-to-date with the current average security clearance times

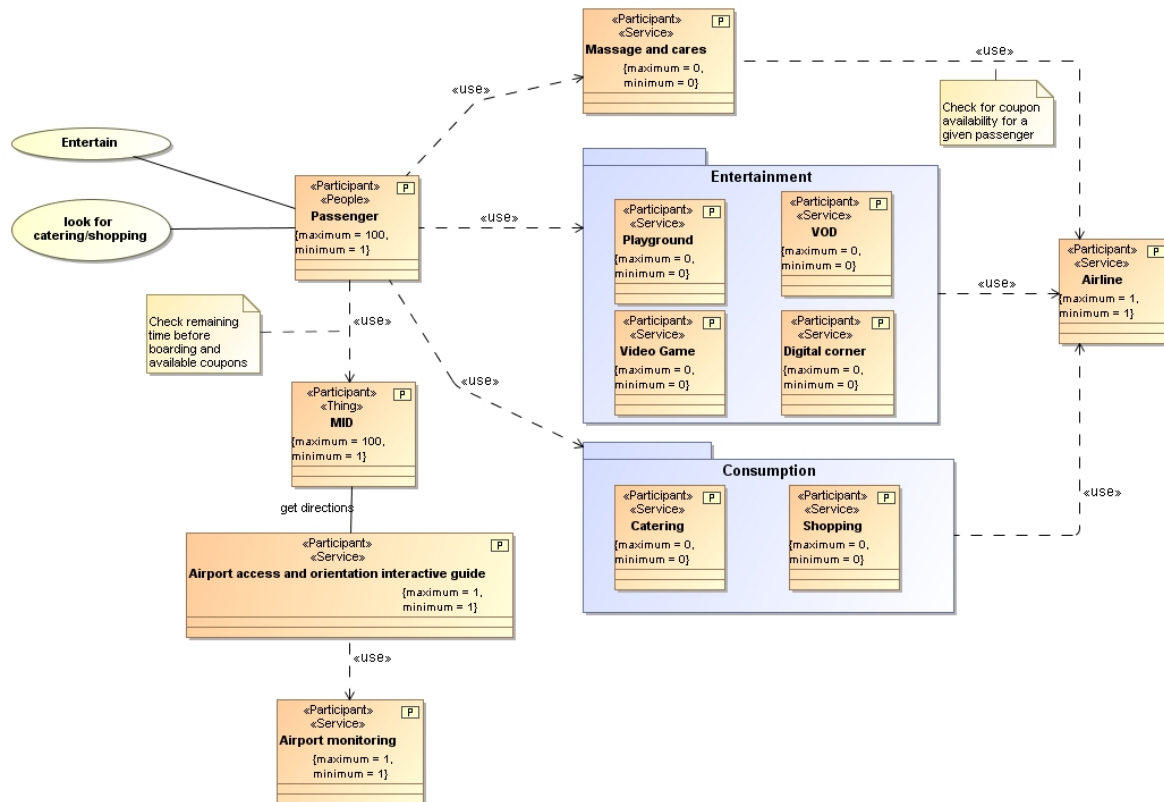
SC1-FR042 - MID security procedures reminder - The MID SHALL remind the passenger of the specific airport's security procedures prior to arriving at the security checkpoint [e.g. remove laptop from bag, remove shoes]

SC1-FR043 - MID special assistance request feature - The passenger SHALL be able to request and arrange special assistance through security clearance using their MID [e.g. children with pushchair, wheel chair etc.]

SC1-FR044 (depends on FR008) - MID duty-free information feature - The passenger SHALL be able to consult on his MID the available facilities beyond the security check (typically duty-free shops), prioritised by user preference [e.g. Identify whether the passenger's favourite coffee shop exists in departures]

SC1-AcR002 - Security to gate delay accuracy - The passenger SHALL be able to get an estimate of how long it will take to get through security and arrive at their gate accurate to 5 minutes

8: Pampering (Optional) - 9: Consumption (Optional)



- + SR001 - Confidentiality
- + SR003 - Dynamic access control to passenger data
- + SR004 - Circle of trust
- + IR001 - MID interoperability
- + IR003 - Human interaction
- + FR006 - MID as boarding pass capability

- * SC1-FR028 - MID geolocation - MID SHALL provide geolocation information (e.g. for itinerary computation)
- * SC1-FR029 - POI retrieval - 'Airport access and orientation interactive guide' service SHALL be able to answer passengers POI requests and provide multiple alternative answers if available
- * SC1-FR030 (depends on FR008) - Alternate route computation - 'Airport access and orientation interactive guide' service SHALL be able to provide alternate routes to reach a given POI, according to airport congestion and user preferences (e.g. reduced mobility passenger)

SC1-FR045 - MID pampering facilities localization feature - The passenger SHALL be made aware of pampering facilities via their MID

SC1-FR046 - MID pampering facilities booking feature - The passenger SHALL be able to book pampering facilities in advance using their MID [e.g. massages, sleeping pods, entertainment]

SC1-FR047 - MID passenger orientation to quiet area feature - The passenger SHALL be able to find the quietest part of the airport as directed by their MID.

SC1-FR048 - MID passenger seating advice feature - The passenger SHALL be able to find available seating in departures as directed by their MID.

SC1-FR049 - MID social features - The passenger SHALL be able to use its MID for social media with other passengers in the airport to meet like minded travel companions

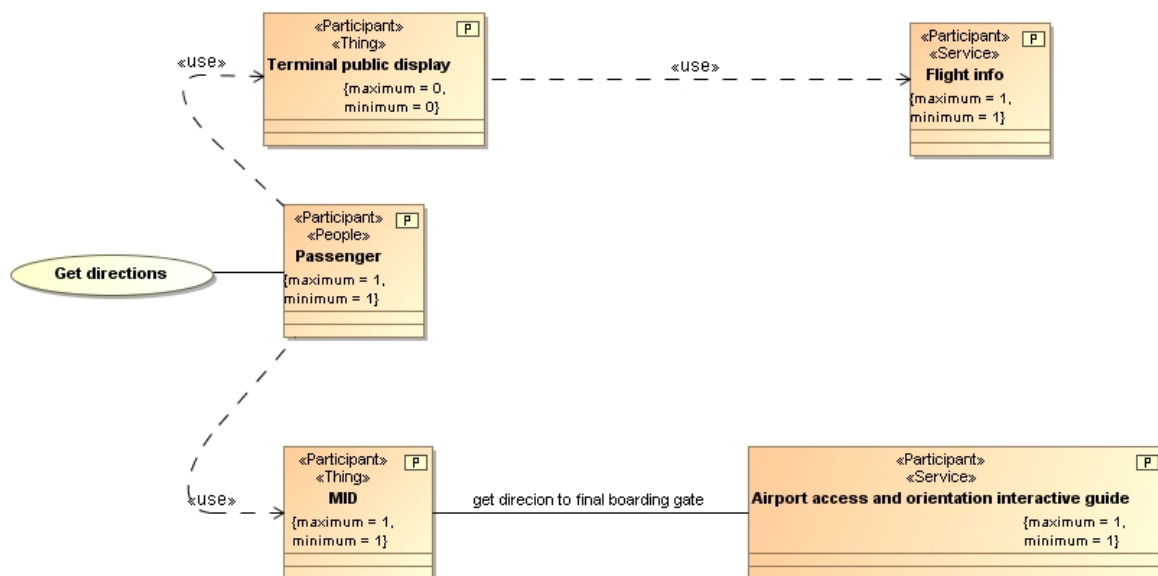
SC1-FR050 - MID social features (continued) - The passenger SHALL be able to read passenger reviews on the airport services and facilities through his MID [e.g. ratings on restaurants and coffee shops]

SC1-FR051 - MID restaurant information feature - The passenger SHALL be able to view the current average serving times of the airport restaurants through his MID

SC1-SR013 (based on SR004) - Business partnership - In the context of business partnership established between airlines and pampering/consumption companies, coupon and billing information SHOULD be exchanged

SC1-AwR004 - Travel rules awareness - Consumption services SHOULD be aware of travel and goods transportation policies relevant to each passenger when selling articles/food. These policies can change according to each passenger final destination

10: Boarding at gate



- + IR001 - MID interoperability
- + IR003 - Human interaction
- + FR006 - MID as boarding pass capability
- + FR009 - MID reminder capability

* SC1-FR028 - MID geolocation - MID SHALL provide geolocation information (e.g. for itinerary computation)

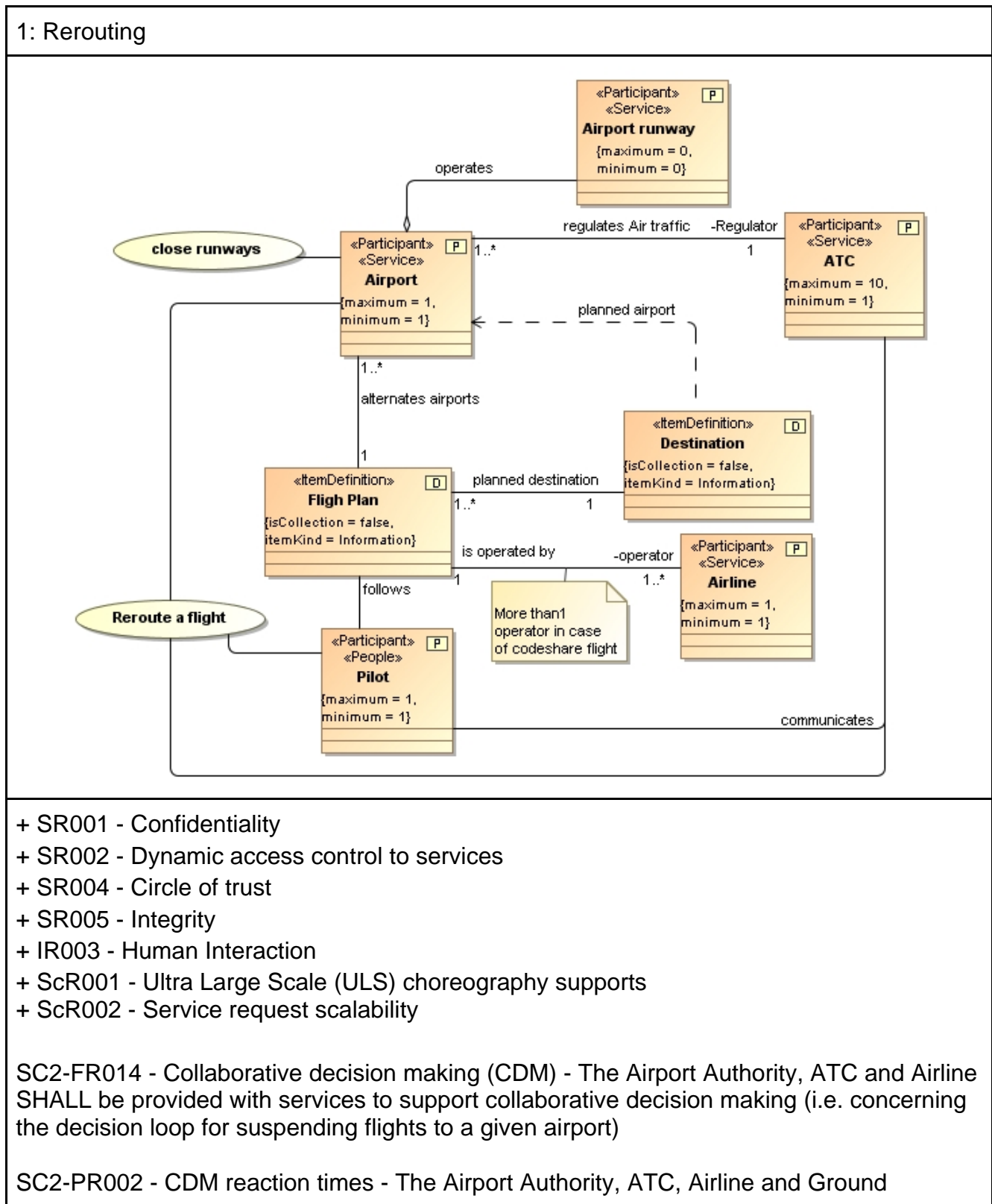
SC1-FR052 - Gate location retrieval - 'Airport access and orientation interactive guide' service SHALL be able to provide passengers with their gate assignment and location, as well as related contextual information [e.g. facilities available at (or near) gate]

SC1-FR053 (depends on FR008) - Alternate route to gate computation - 'Airport access and orientation interactive guide' service SHALL be able to provide alternate routes to reach a given boarding gate, according to airport congestion and user preferences (e.g. reduced mobility passenger)

SC1-FR054 (based on SC1-FR052 and SC1-FR053) - MID gate assignment localization feature - The passenger SHALL be given instructions on his MID for finding his gate assignment

SC1-FR055 (based on SC1-FR052) - MID bathroom before boarding notification feature - The passenger SHALL be notified by their MID of the last available bathroom facilities prior to boarding the flight
 SC1-FR056 (based on SC1-FR052) - MID facilities near gates feature - The passenger SHALL be able to see on his MID what facilities are available at their boarding gate [e.g. vending machine, free newspapers, television]

4.4. Step-level requirements for scenario “Bad weather at destination”



Handlers SHALL be provided with real-time information sharing (e.g. reaction times less than 10 seconds)

SC2-PR003- Reroute request delay - The pilot MUST be made aware of its reroute request in less than 5 seconds after it has been launched by ATC

SC2-PR004 - Delay to inform all planes - All planes impacted by weather conditions at airport (in flight or on the ground before takeoff) MUST be made aware of runways closing in less than 15 minutes.

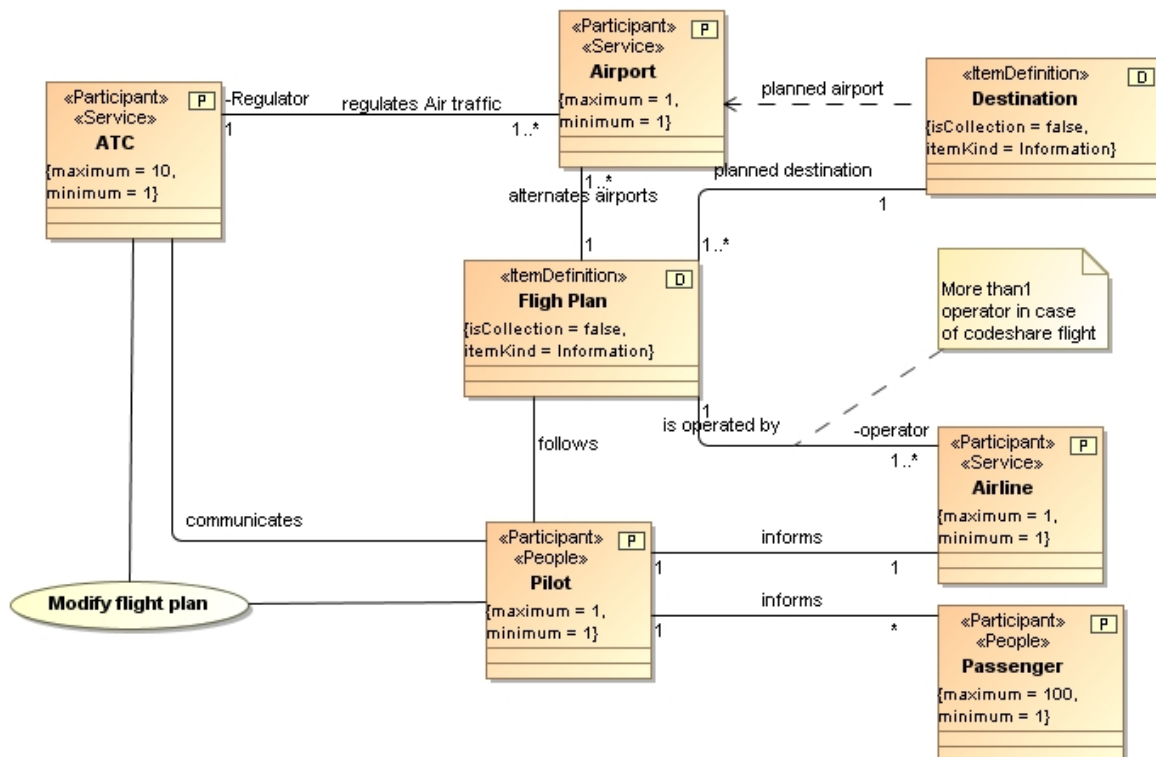
SC2-PR005- Delay to close runways - After decision has been made by local airport authorities, all airport runways SHOULD be closed in less than 30 minutes.

SC2-AvR001 - Flight plan access - ATC SHALL be able to able to access flight plans for all flights going to or departing from its airport at all times.

SC2-ScR004 (based on ScR001) - Plane rerouting scalability - Planes rerouting choreography MUST be able to deal with significant variations in the number of planes that need to be notified (depending on the day, time, period of the year and size of the airport/hub).

SC2-AwR001 - ATC weather awareness - ATC SHALL be aware at all time of current airport conditions (i.e. 24/7 access to weather forecast service).

2: Flight plan modification



+ SR001 - Confidentiality

+ SR002 - Dynamic access control to services

- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR003 - Human Interaction
- + ScR001 - Ultra Large Scale (ULS) choreography supports
- + ScR002 - Service request scalability

SC2-PR006 - Reroute agreement delay - Agreement on final destination between the pilot and ATC SHALL take less than 10 minutes.

SC2-PR007 - Agreement broadcasting delay - Agreement on final destination, when found, SHALL be transferred to airline operating the flight and alternate destination airport and in less than 3 minutes.

SC2-AvR002 - Alternate airport list availability - The pilot MUST be able to access the pre-computed list of alternate airports at his disposal at any time during the flight

SC2-AcR001 - Arrival time accuracy - When alternate destination airport is notified of a new airplane arrival, the time of arrival SHALL be accurate to the minute.

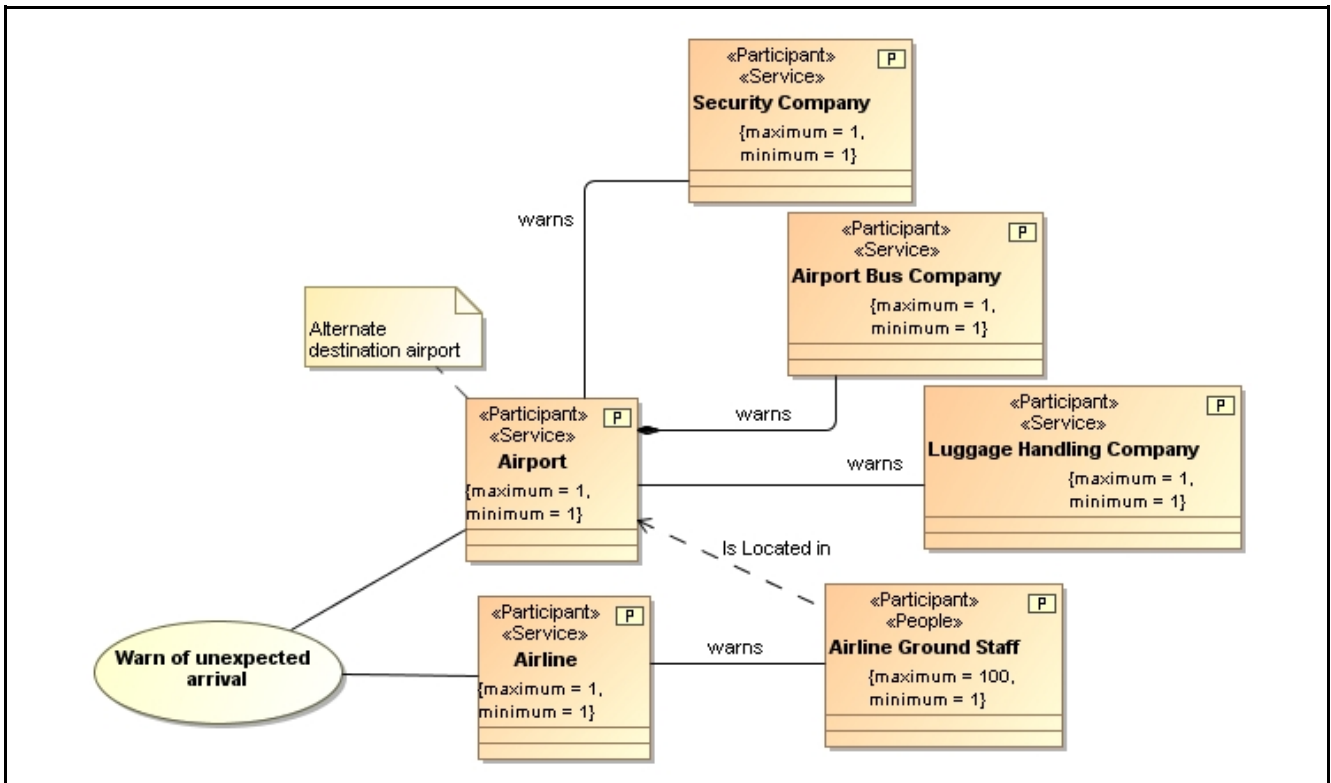
SC2-IR006 - Plane communication channels interoperability - The pilot MUST be able to communicate with alternate destination airport even if it offers slightly different services compared to original destination airport.

SC2-IR007 (supports AwR002) - Take-off and landing information coordination - ATC, Airline and slot allocation coordination SHOULD also consider the passenger as part of the information process (i.e. to keep passengers better informed of flight take-off and landing)

SC2-AwR002 - Passenger rerouting awareness - The passenger SHALL be made aware of main rerouting event at all time.

SC2-RR003 - Plane communication channels reliability - critical communication channels used for communication between the pilot and ATC MUST achieve 99% up-time.

3: Unexpected arrival warning



- + SR001 - Confidentiality
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR002 - Dynamic service discovery
- + IR004 - Runtime flexibility
- + ScR001 - Ultra Large Scale (ULS) choreography supports
- + ScR002 - Service request scalability

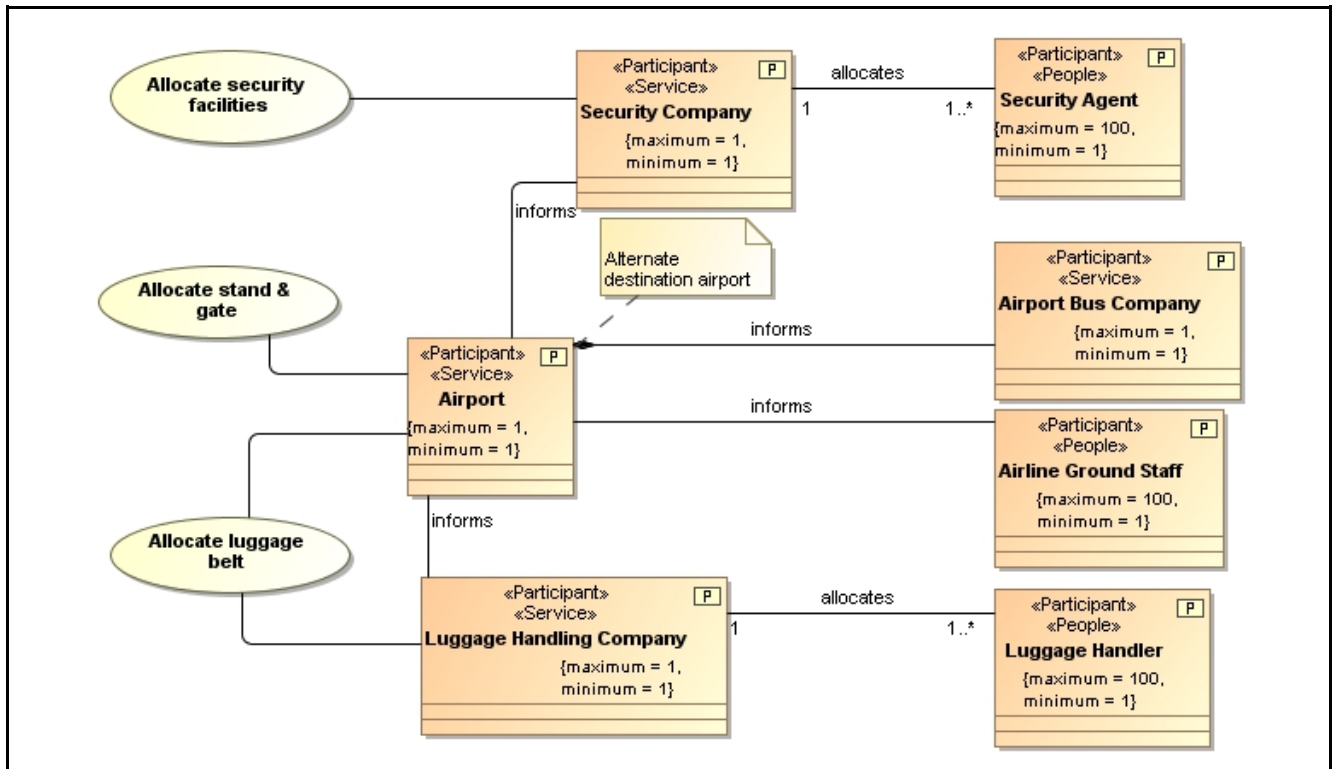
SC2-FR015 - Unified warning interface - The Security Company, Airport Bus Company and Luggage Handling Company services SHALL support an unified warning interface.

SC2-FR016 - Airline ground staff ability to deal with rerouting - The airline ground staff at alternate airport SHALL be able to organize and put in place any amenities needed for new plane and passengers arrival.

SC2-PR008 - Alternate airport personnel time to prepare - All impacted actors at alternate airport SHALL be warned at least 15 min before plane arrival (based on arrival time communicated in previous step).

SC2-AvR003 - Alternate airport personnel availability - All impacted actors at alternate airport MUST be available to take into account the unexpected arrival warning at any time of the day (except during airport/runway closing ours, as implemented for specific airports).

4: Unexpected arrival handling



- + SR001 - Confidentiality
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR002 - Dynamic service discovery
- + IR004 - Runtime flexibility
- + ScR001 - Ultra Large Scale (ULS) choreography supports
- + ScR002 - Service request scalability

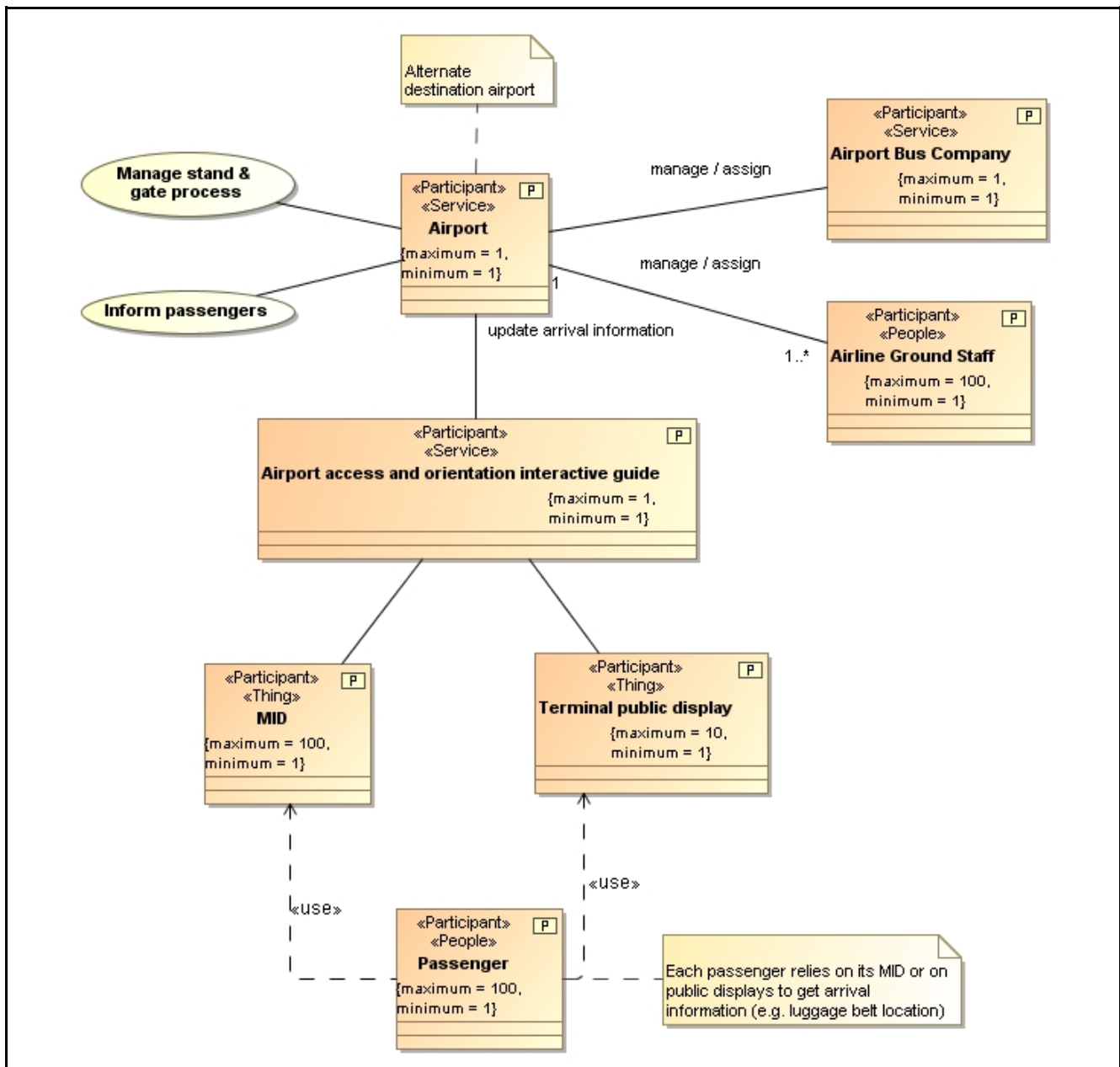
SC2-FR017 - Location of luggage handlers - Location of luggage handlers **MUST** be known at all times by airport authority and luggage handling company in order to avoid luggage theft in passenger-restricted zones of the airport.

SC2-AvR004 - Airport congestion value availability - The current airport congestion status **SHALL** be already computed and available when requested by airport authority and/or personnel, in order to reduce waiting time.

SC2-AwR003 - Airport congestion awareness - Airport authority and personnel **SHALL** be aware of current airport congestion at any time

SC2-AdR001 - Adaptability to airport congestion - Airport authority and personnel **MUST** adapt stand and gate allocation based on the current congestion and usage of the airport, mostly to avoid amplification of this congestion and reduce passenger stress.

5: Arrival handling



- + SR001 - Confidentiality
- + SR003 - Dynamic access to passenger data
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR001 - MID interoperability
- + IR002 - Dynamic service discovery
- + IR004 - Runtime flexibility
- + ScR001 - Ultra Large Scale (ULS) choreography supports
- + ScR002 - Service request scalability
- + FR013 - MID event plan updates capability
- + PR001 - Flight status updates

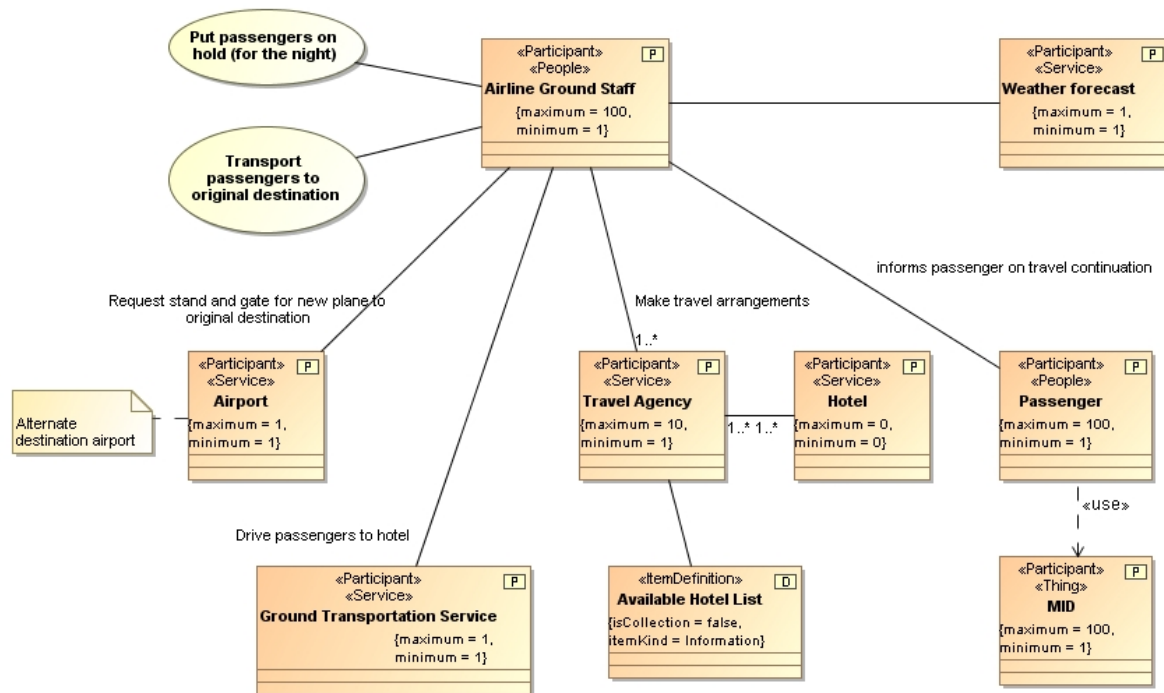
SC2-FR018 - Push of information to passengers' MID - Information SHOULD be delivered to arriving passengers through their MID as soon as they are online (using a 'PUSH' communication paradigm)

SC2-ScR005 - Passenger arrival scalability - Running choreographies at the alternate airport MUST accommodate the sudden increase of passengers to coordinate resulting

from the arrival of their plane. This increase varies greatly depending on the type/size of the plane.

SC2-AwR004 - Passenger information awareness - The passenger **MUST** be made aware of location of luggage belt and airline counter through any means possible (Terminal public displays, MIDs, ...)

6: Local crisis management



- + SR001 - Confidentiality
- + SR003 - Dynamic access to passenger data
- + SR004 - Circle of trust
- + SR005 - Integrity
- + IR001 - MID interoperability
- + IR002 - Dynamic service discovery
- + IR004 - Runtime flexibility
- + ScR001 - Ultra Large Scale (ULS) choreography supports
- + ScR002 - Service request scalability
- + FR007 - Passenger preference definition
- + FR013 - MID event plan updates capability
- + PR001 - Flight status updates

SC2-FR019 - Passenger preference for rerouting - The preferences of a passenger **SHOULD** be taken into account when deciding to put him on hold for the night (e.g. preference over a particular kind of hotel) or transporting him to its original destination (e.g. preferences for new plane reservation)

SC2-FR020 - Rerouting decision - Airline ground staff **SHOULD** decide on travel continuation modalities according to all available information (including weather forecasts).

SC2-FR021 - External crisis communication - The Airport Authority **SHOULD** provide up-to-

date crisis information via different media (e.g. regular website updates, press releases, real-time twitter posts and responses)

SC2-PR009- Rerouting - Passengers and their travel agencies SHOULD be informed of rerouting decision 2 hours after landing at the latest.

SC2-AcR002 - Accurate information for passengers - The Airport Authority and Airline SHALL have the means to coordinate to provide consistent information to passengers.

SC2-SR006 - Passenger data privacy - The privacy of passenger data needed for organizing travel continuation, and exchanged between multiple parties to this end, MUST be preserved.

4.5. Summary and analysis of requirements

In total, 125 requirements were specified during the elicitation process. This total includes 29 system-wide requirements specified across both scenarios, 63 step-level requirements for the “from planning to boarding” scenario, and 33 step-level requirements for the “bad weather at destination” scenario.

The requirements specified for the “from planning to boarding” scenario were mainly functional, 43 of them, and these added detail and definition to the steps in the scenario. There was a reasonable coverage across the non-functional requirements types, with 5 specified in total across 9 types selected for the requirements specification. A further non-functional requirement type, interoperability, was represented by system-wide requirements associated with individual steps of the scenario.

For the “bad weather at destination” scenario, the predominant requirements types were functional and performance, with 8 specified for each. There was a strong emphasis on non-functional requirements for this scenario, with coverage of all 9 types across the 6 steps. As the systems in this scenario already exist, the focus of the elicitation exercise was to reflect areas where CHOReOS could add value through integration, hence the specification of more non-functional rather than functional requirements.

A breakdown of the requirements by type for both scenarios is presented in Table 5.

Requirement type	Scenario 1 requirements	Scenario 2 requirements
Functional [FR]	43	8
Performance [PR]	3	8
Availability [AvR]	0	4
Accuracy [AcR]	2	2
Security [SR]	8	1
Scalability [ScR]	3	2
Interoperability [IR]	0	2
Awareness [AwR]	4	4

Requirement type	Scenario 1 requirements	Scenario 2 requirements
Adaptability [AdR]	0	1
Reliability [RR]	0	1
Total	63	33

Table 5 - Number of requirements by type for each scenario

4.5.1. Analysis with respect to the FI challenges and requirements

In this section, the requirements elicited from the passenger-friendly airport use case are analysed with respect to the CHOReOS Future Internet challenges and requirements from deliverable D1.2 [1].

Scalability

Scalability can be viewed from a number of dimensions – the number, size and quality of networked entities; storage (scale and size of content and sensors' data); discovery (search and retrieval); streaming data, addressing and naming.

For the number and size of networked entities, an example where this requirement is appropriate is in scenario 2 step 1 - the notification of plane rerouting. The following requirement depends on the message scaling to all planes concerned:

SC2-ScR004 (based on ScR001) - Plane rerouting scalability - Planes rerouting choreography MUST be able to deal with significant variations in the number of planes that need to be notified (depending on the day, time, period of the year and size of the airport/hub).

Storage is not expected to be an issue. As an example, however, the system-wide requirement for the MID to adapt to passenger preferences and behaviours assumes that the MID will be able to store the size of data required:

FR008 - MID adaptation to passenger preferences and behaviours - The MID SHALL update the user profile based on stated preferences and behaviours from the passenger over time

Some step-level requirements in scenario 1 depend on this system-wide requirement, for example:

SC1-FR023 (depends on FR008) - Parking selection - The passenger SHALL be able to select his parking based on a set of preference criteria [e.g. availability, location, parking space size and price]

Discovery is a challenge, as demonstrated by the MID's friend tracking capability which needs to coordinate location and social connection under constraints such as time.

FR010 - MID friend tracking capability - The passenger SHALL be able to track friends and colleagues in the airport using their MIDs and location based services

Streaming large quantities of data is a challenge that is not specifically captured in the requirements specification for this Use Case, however it could be implied as possible solutions for the following requirements:

SC1-FR041 - Security clearance delay information - The passenger SHALL be kept up-to-date with the current average security clearance times

SC1-FR042 - MID security procedures reminder - The MID SHALL remind the passenger of the specific airport's security procedures prior to arriving at the security checkpoint [e.g. remove laptop from bag, remove shoes]

The first requirement could be implemented by providing a live video feed of security queues to the passenger's MID, and the second could be met via a streamed demonstration video.

Finally, addressing and naming of devices assume IPv6 and DNS, and is expected to suffice for this Use Case. No particular requirements from the passenger-friendly airport scenarios relate to this aspect of scalability.

Interoperability

The interoperability of heterogeneous components, for example the different devices or MIDs that need to be deployed in the choreographies, is considered the system-wide requirement:

IR001 - MID interoperability - A passenger's MID SHALL be able to transparently access services of different types, technologies, and provided by different entities (e.g. airport, airline, ...)

Another system-wide requirement relates to MID to MID interoperability:

IR005 - MID to MID interoperability - The passenger SHALL be able to transfer information views from one MID to another

Dynamic content integration is an important consideration, particularly when considering the composition of information for passengers and the different data views they will need from the operational actors (e.g., ATC, pilots, airlines and airport officers). For example, keeping the passenger in the loop on possible rerouting in scenario 2:

SC2-IR007 (supports AwR002) - Take-off and landing information coordination - ATC, Airline and slot allocation coordination SHOULD also consider the passenger as part of the information process (i.e. to keep passengers better informed of flight take-off and landing)

The Passenger-friendly Airport Use Case relies upon dynamic service discovery and composition as specified in the system-wide requirement:

IR002 - Dynamic service discovery - In this UC, a flight can be rerouted and critical services from new destination infrastructures need to be discovered since they differ from the original destination. As such, the system MUST support the dynamic discovery of services during the enactment of choreographies.

Overall, the presence of system-wide interoperability requirements and their inclusion in the steps of both scenarios emphasises the importance of interoperability for this Use Case.

Awareness and Adaptability

Being aware of context is important in this use case, in particular the awareness of weather and congestion, as reflected in the following two requirements:

SC2-AwR001 - ATC weather awareness - ATC SHALL be aware at all time of current airport conditions (i.e. 24/7 access to weather forecast service)

SC2-AwR003 - Airport congestion awareness - Airport authority and personnel SHALL be aware of current airport congestion at any time

Self-awareness (healing, optimization, configuration, maintenance) is an important consideration in this Use Case. For example, the self-optimisation of the provision of particular services, such as:

SC1-AwR003 - Automatic Gates provision - For a specific time period, the amount of automatic gates implemented (and associated security agent reserved) SHOULD match the planned amount of passenger with automatic security clearance expected

Awareness includes monitoring, predicting, and knowing what passengers are doing, e.g.:

SC1-AwR002 - Passenger density at check-in awareness - The passenger SHALL be made aware of the quickest check-in option and location based on current passenger density information

Associated with awareness is adaptability, which is the ability of the system to adapt to predicted or known changes in context or specification. A particularly important aspect of this Use Case is the ability for airport operation to adapt to airport congestion, as specified in the following adaptability requirement:

SC2-AdR001 - Adaptability to airport congestion - Airport authority and personnel MUST adapt stand and gate allocation based on the current congestion and usage of the airport, mostly to avoid amplification of this congestion and reduce passenger stress.

Finally, it is worth considering the link between awareness and resilience against accidents and failures. Awareness can lead to reduced recovery times and improved up-time reliability which is important across both scenarios, for example:

SC2-RR003 - Plane communication channels reliability - critical communication channels used for communication between the pilot and ATC MUST achieve 99% up-time.

5. Choreographies description

In this section we give a seminal high-level definition of the choreographies, based on the BPMN standard, that manage the two scenarios of this use case, based on the descriptions given in Chapters 2 and 3. These choreographies formalize people, service and things interactions that happen during the various steps of each scenario, from a global point of view.

To better understand the diagrams presented below we give a brief overview of the BPMN elements that we use in our choreographies:

- Flow objects: objects that interrupt the sequence flow and may lead to divergence/convergence.
- Connecting objects: objects that represent different types of associations between flow objects/data etc.

In order to implement the choreographies we used MagicDraw Enterprise edition 17.0 modeling suite. Many tools and plugins are featured in this edition that aid the business modeler to leverage on the benefits of the UML and BPMN standards so as to design, create and test BPMN diagrams.

5.1. For scenario 1 - “From planning to boarding”

We introduce hereafter the choreographies pertaining to Scenario 1, “From planning to boarding”, starting from the global choreography and followed by the sub-choreographies managing each of its individual steps.

5.1.1. Global choreography

The following global choreography (see Figure 3) defines the coarse-grained chain of elementary steps that passengers will follow from planning their trip, up to boarding their plane. It includes *arrival at the airport*, *check-in at company counter*, *security checks*, etc. The passenger is thus one of the principal actor of this choreography, since its focus is to state the relationship between various actions it can undertake (e.g. go shopping) or be subjected to (e.g. pass security checkpoints) upon arrival at the airport.

In this choreography, most of the steps are mandatory in the sense that any passenger must go through them in order to be able to board a plane; while some other steps are optional: for instance, *consumption* and *pampering* steps are non-compulsory and the passenger is free to skip them to board his plane quicker, or if he is late.

Another important aspect of the following choreography, including its sub-choreographies shown in the consecutive sections, is that, for simplification purpose, we focus on the choreography as viewed from the specific angle of one particular passenger or small group of passengers (e.g., a family) that simultaneously follow a predefined and ordered set of steps. The direct consequence of this assumption is that there will be approximately **as many instances of this global choreography and sub-choreographies in the system as their are passengers to be managed in the airport**. This exemplifies one of the (ultra) large scale problems that must be dealt with by the CHOReOS choreography runtime.

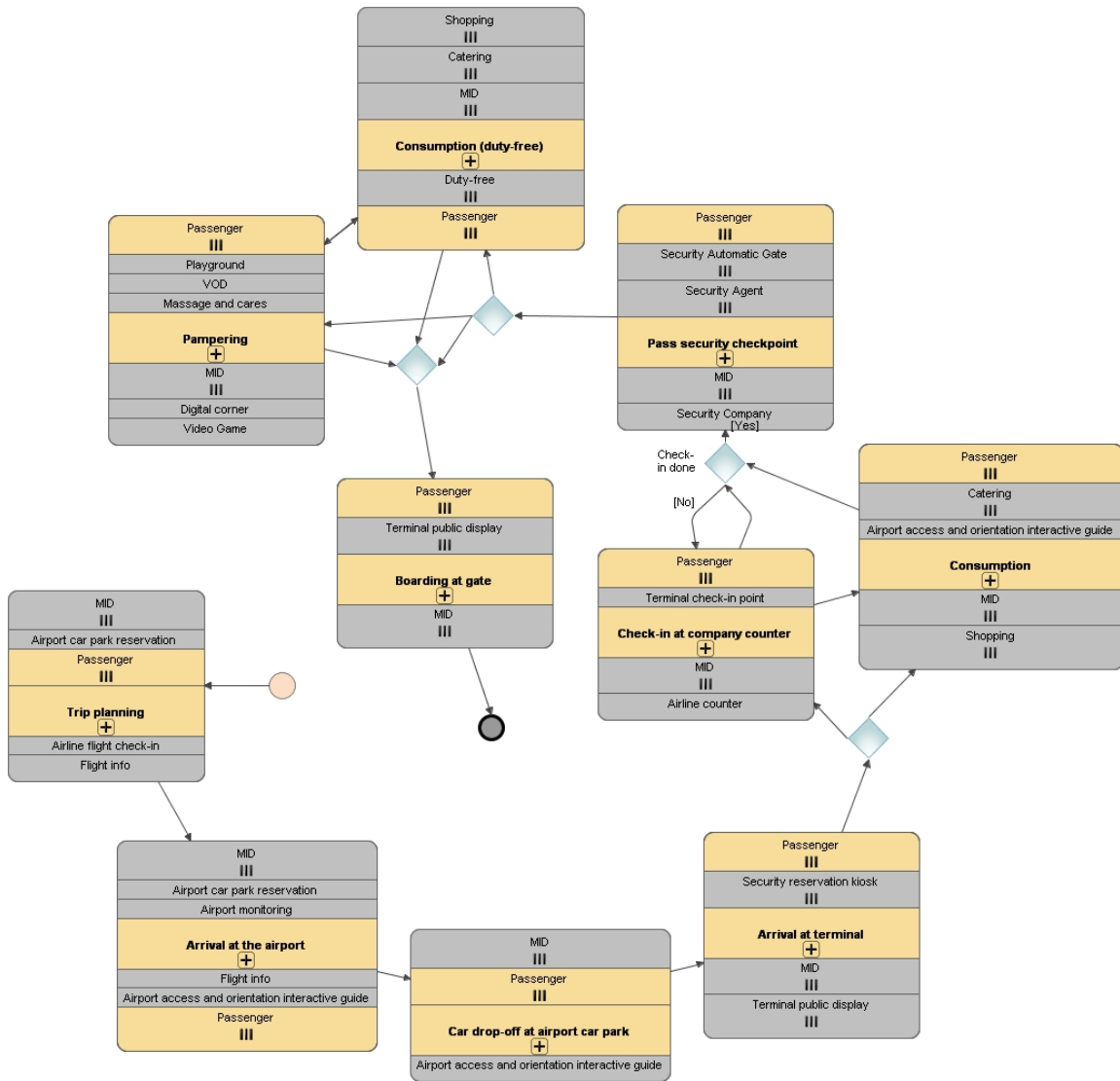


Figure 3 - BPMN diagram of scenario 1 global choreography

5.1.2. Step 1 - "Trip planning" sub-choreography

In this first step, the passenger is using his MID and home Internet connection to (pre)check-in and make a reservation at the airport car park. This process relies on services the MID is able to access over the Internet using Wifi.

Before leaving home, the passenger is also able to check traffic information through his MID.

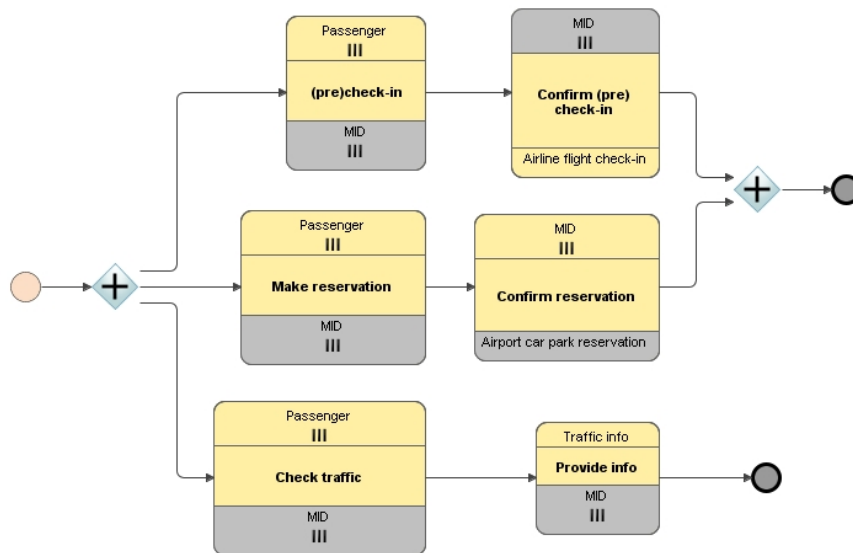


Figure 4 - BPMN diagram of scenario 1 - step 1 sub-choreography

5.1.3. Step 2 - “Arrival at the airport” sub-choreography

In the second step, the passenger is able to retrieve last-minute directions to car park and terminal through his MID, by relying on multiple services available using its wireless mobile connection (e.g. EDGE, 3G, UMTS). The passenger then follow this direction using his MID onscreen and vocal indications.

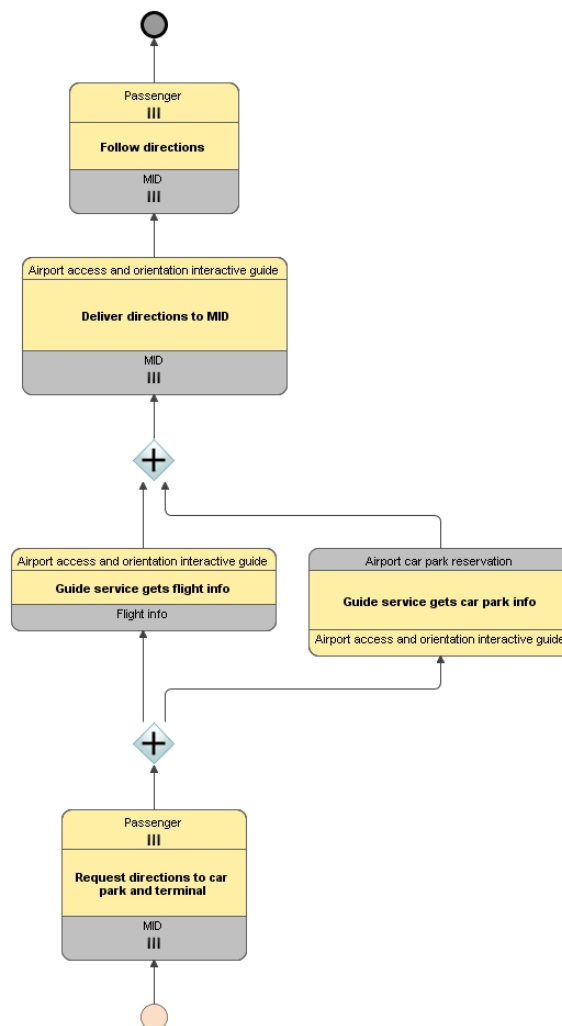


Figure 5 - BPMN diagram of scenario 1 - step 2 sub-choreography

5.1.4. Step 3 - “Car drop-off at airport car park” sub-choreography

In Step 3, the passenger, after dropping his car off at the airport car park, follows external signalization as well as indications coming from his MID to get to the terminal. He can recall last obtained directions at any time on his MID.

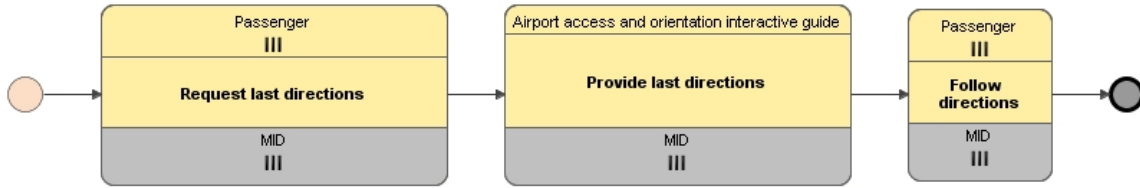


Figure 6 - BPMN diagram of scenario 1 - step 3 sub-choreography

5.1.5. Step 4 - “Arrival at terminal” sub-choreography

In Step 4, the passenger has the possibility to register for automatic security access to the checkpoints in order to gain time for this and future flights. In order to do so he needs to interact with a security agent that can grant or deny this access depending on provided security documents and security records (e.g. from law-enforcement agencies). He can also skip this registration altogether and look for his departure zone in the terminal public displays in order to finish check-in procedure (started in Step 1, at home, with (pre)check-in) and/or do baggage drop-off, if needed.

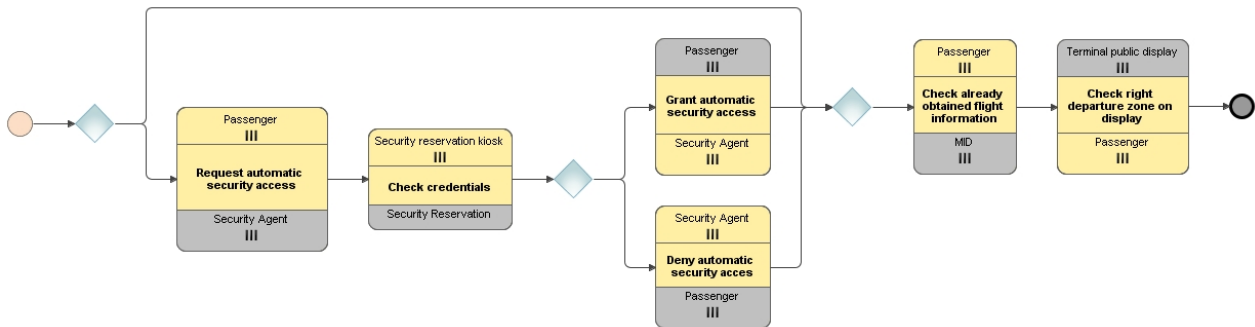


Figure 7 - BPMN diagram of scenario 1 - step 4 sub-choreography

5.1.6. Step 5 - “Check-in at company counter” sub-choreography

In Step 5, the passenger has the possibility when checking-in of dropping his baggage off at airline counter, if he has any. In this case he also needs to request his boarding pass at the counter. On the contrary, if he has no baggage to drop-off, the passenger can request his boarding pass at a terminal check-in point, thus reducing his waiting time for check-in.

In both cases, the boarding pass is delivered directly to the passenger’s MID without using paper.

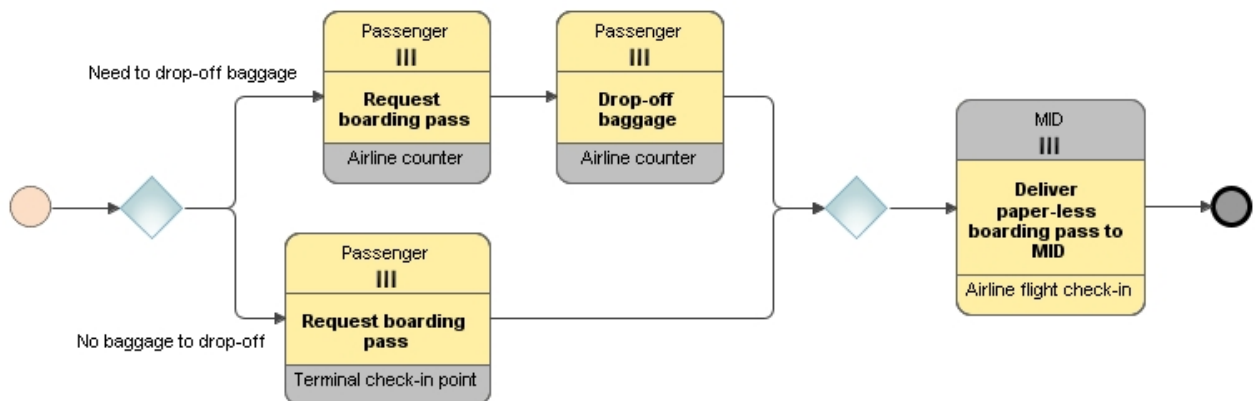


Figure 8 - BPMN diagram of scenario 1 - step 5 sub-choreography

5.1.7. Step 6 - “Consumption” sub-choreography

In Step 6, the passenger can purchase food or goods in the airport terminal, if he chooses to, and also if he has time to. Since security checkpoints have not been cleared at this point, he doesn't have access to Duty-free shops.

To get to the consumption zone of the airport where he can find catering and shopping facilities, the passenger uses his MID to retrieve directions that take into account the current congestion of the airport: this is possible since the *Airport access and orientation interactive guide* service is connected to an *Airport monitoring* service that can retrieve congestion information from sensors all over the airport terminal.

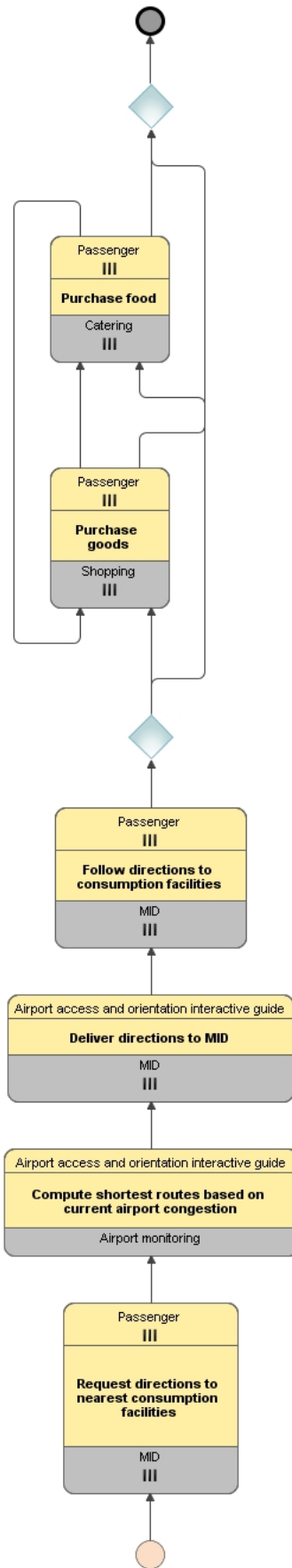


Figure 9 - BPMN diagram of scenario 1 - step 6 sub-choreography

5.1.8. Step 7 - “Pass security checkpoint” sub-choreography

In Step 7, the passenger needs to pass security checkpoints, either ‘automatically’ if he was able to register for automatic access (in Step 4), or through a Security agent if he wasn’t.

In the first case, the passenger only has to provide his paperless boarding pass that is scanned by the Security Automatic Gate using a QR-code². In the second case, he has to provide his boarding pass as well as identification documents that need to be verified by the security agent.

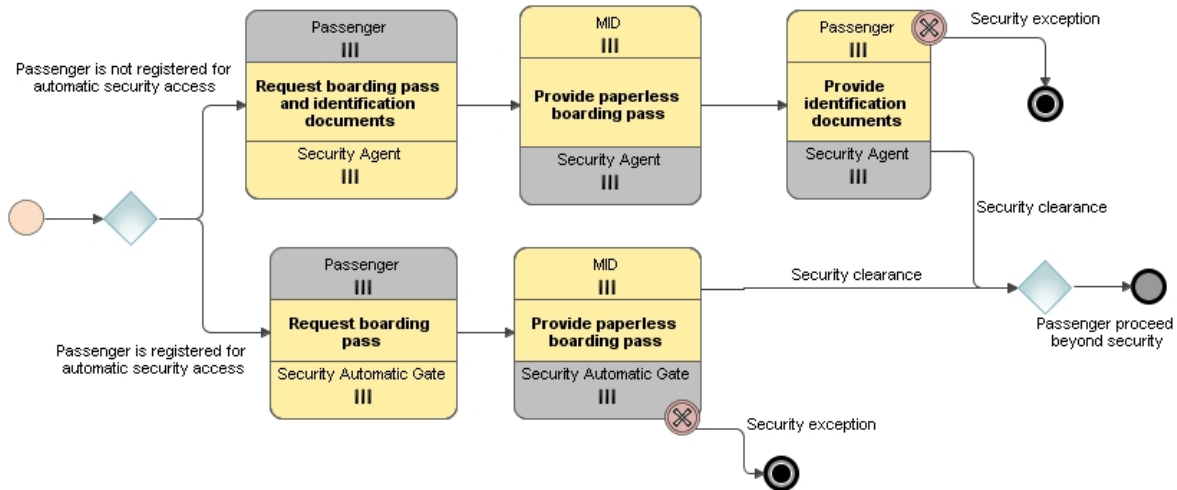


Figure 10 - BPMN diagram of scenario 1 - step 7 sub-choreography

5.1.9. Steps 8 - “Pampering” and 9 - “Consumption” sub-choreography

The following choreography gives a joint view of the intertwined actions of Steps 8 and 9. Indeed, upon clearing security checkpoints (Step 7), the passenger his able to get to consumption (including *food* and *goods purchasing*) and pampering facilities (including *Playground*, *Video Game* and *Digital Corner*), but also to move freely from one activity to another. This explains why Steps 8 and 9 are presented on the same BPMN choreography diagram.

For each activity, passenger-dedicated coupons can be retrieved from its airline, if available, and used to pay. The *Airline* service is thus able to answer coupon request if provided with passenger identification information.

²http://en.wikipedia.org/wiki/QR_code

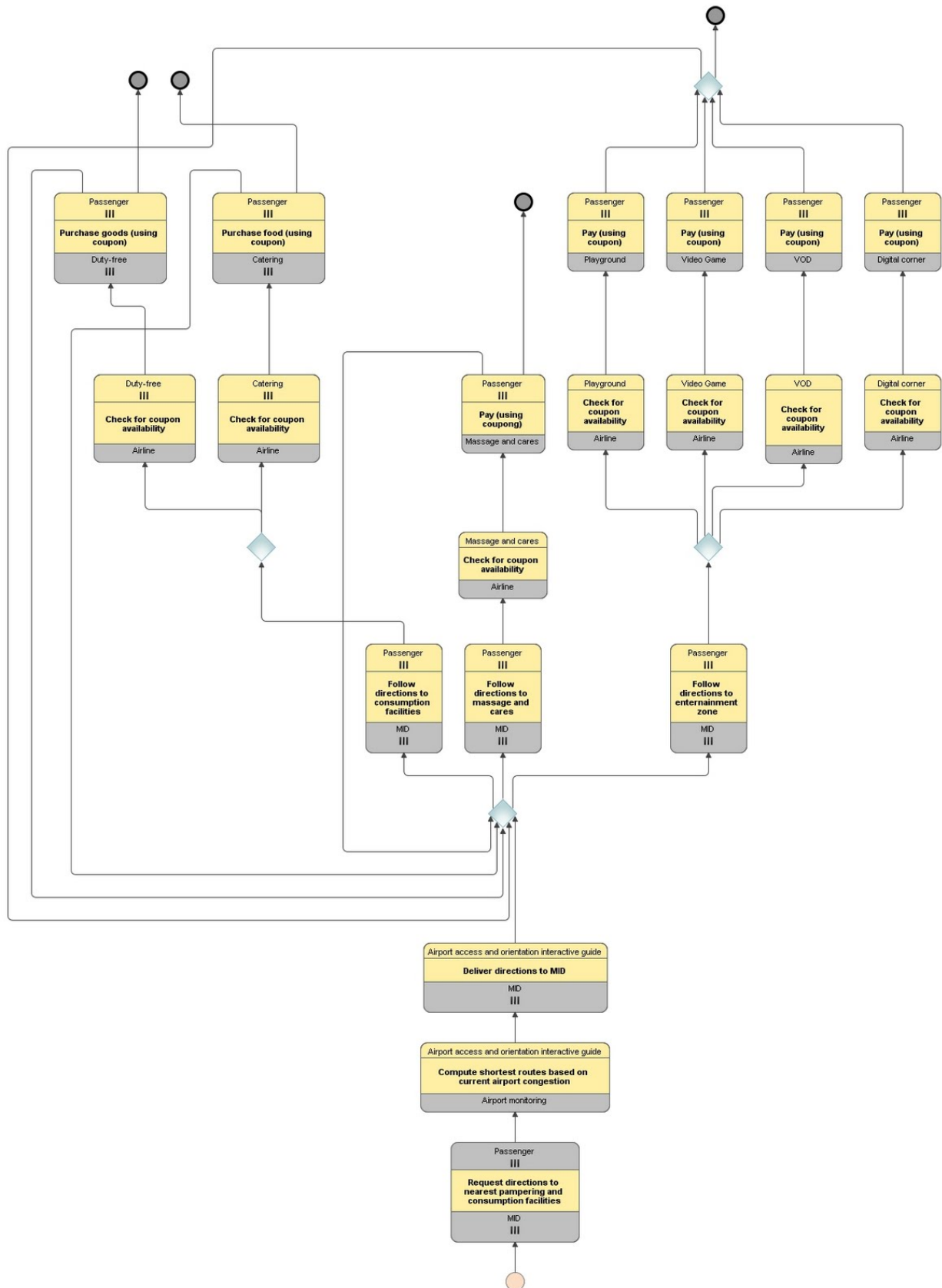


Figure 11 - BPMN diagram of scenario 1 - steps 8 and 9 sub-choreography

5.1.10. Step 10 - “Boarding at gate” sub-choreography

In Step 10, the final step of the global choreography, the passenger needs to proceed to his identified boarding gate. To do so, he needs to check terminal public displays for gate assignment and can then request directions to this gate using his MID that is connected to

the *Airport access and orientation interactive guide* service. Terminal public displays are continuously updated with flight information coming from the dedicated *Flight info* service.

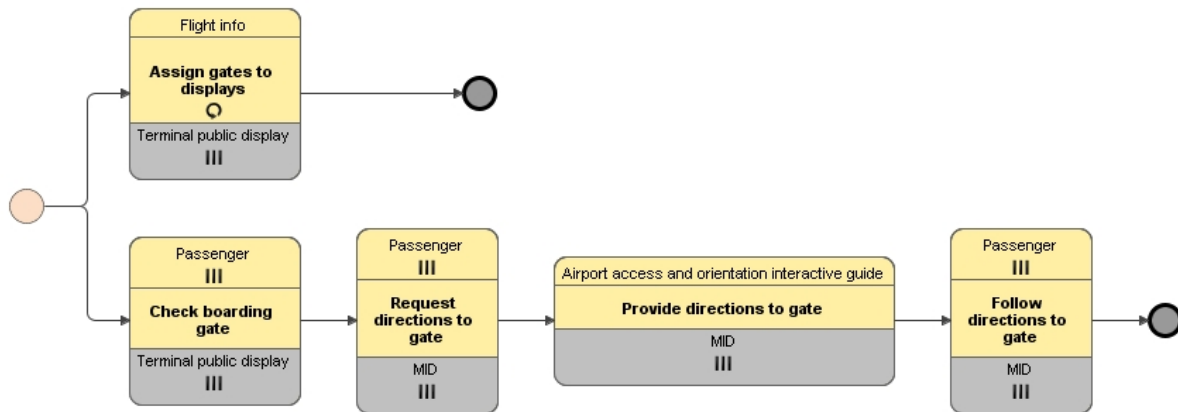


Figure 12 - BPMN diagram of scenario 1 - step 10 sub-choreography

5.2. For scenario 2 - “Bad weather at destination”

We introduce hereafter the choreographies pertaining to scenario 1, called “Bad weather at destination”, starting from the global choreography and followed by a dedicated sub-choreographies managing the unexpected arrival of passengers at an alternative airport.

5.2.1. Global choreography

The following global choreography (see Figure 13) defines all the elementary activities related to dealing with an unexpected flight redirection, including the negotiation of the rerouting between ATC and pilot, passenger information during and after the flight, as well as unexpected arrival handling by airline ground staff.

This second scenario (and its global choreography) is complementary to the first one since the same passengers that have been managed at the airport before boarding can be concerned by a flight rerouting. But, instead of focusing on passenger(s), as did in “From planning to boarding”, this choreography puts multiple actors in the spotlight, including *pilot*, *airline ground staff*, *security agents*, *luggage handlers*, etc.

As for scenario 1, another important aspect of the following choreography, including its sub-choreography, is that, for simplification purpose, we focus on the choreography as viewed from the specific angle of one particular flight. As such, there will be **as many instances of this global choreography in the system as there are flights to be rerouted**. As previously seen, this exemplifies one of the (ultra) large scale problems that must be dealt with by the CHOReOS since, for one rerouting decision a large number (eg. 100+) of flights, and thus simultaneous choreographies, can be impacted.

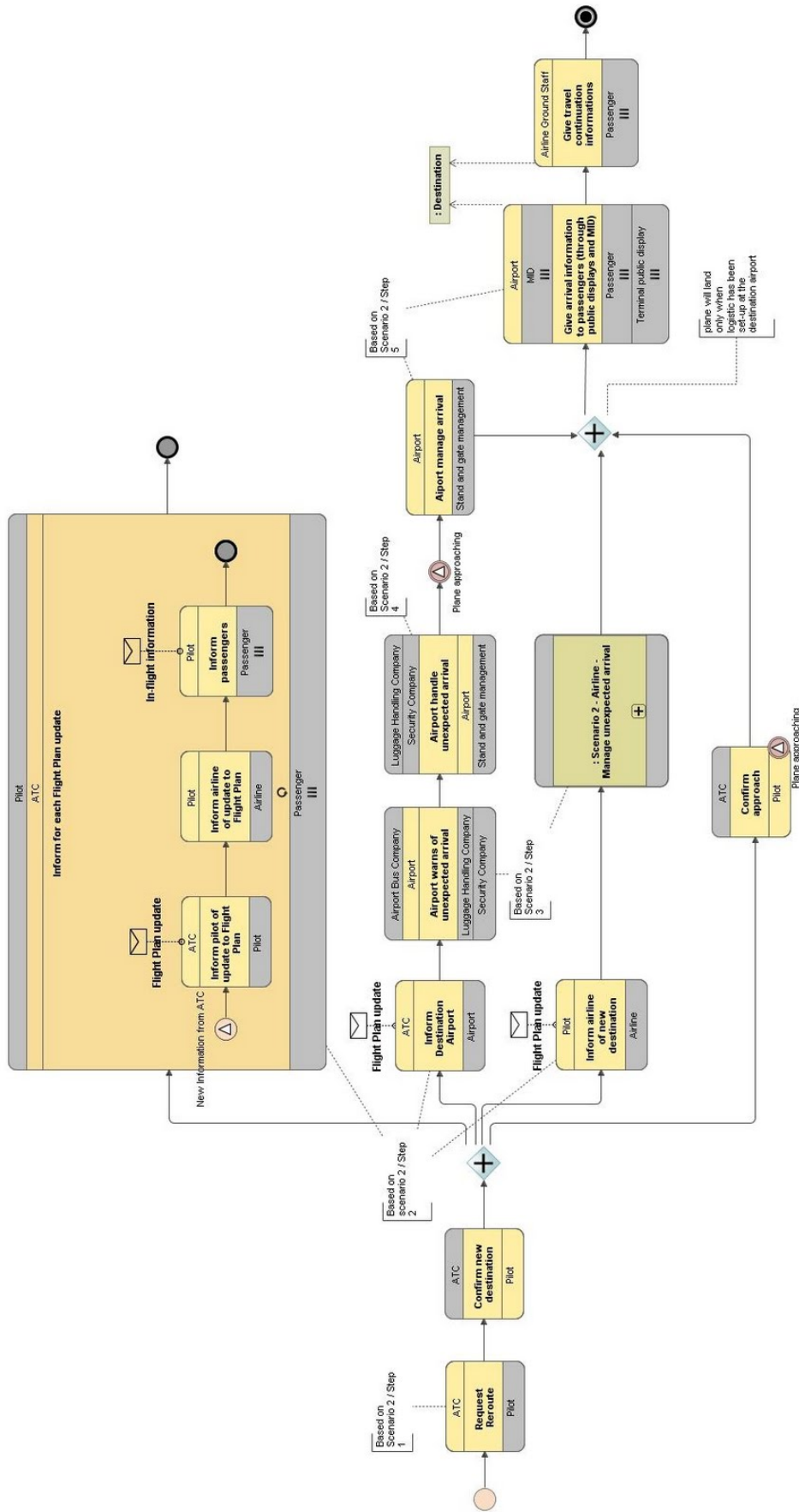


Figure 13 - BPMN diagram of scenario 1 global choreography

5.2.2. “Management of unexpected arrival” sub-choreography

This particular sub-choreography gives the details pertaining to the management of unexpected arrival of passengers at an alternative airport. It includes the pre-emptive decision made by airline ground staff of travel continuation modalities for rerouted passengers, based on weather information gathered from a weather forecast service.

In fact, the airline ground staff needs to decide if it should directly prepare a new flight to their original destination or, if weather is bad, to put them on hold for the night. Both cases imply logistic consequences: for instance, putting passenger on hold for the night means that information will need to be exchanged with travel agencies of passengers, hotels will be booked for one night and, finally, ground transportation will need to be allotted in order to convey passengers to these hotels. The main idea being to put everything in place before plane landing and passenger arrival at the airport.

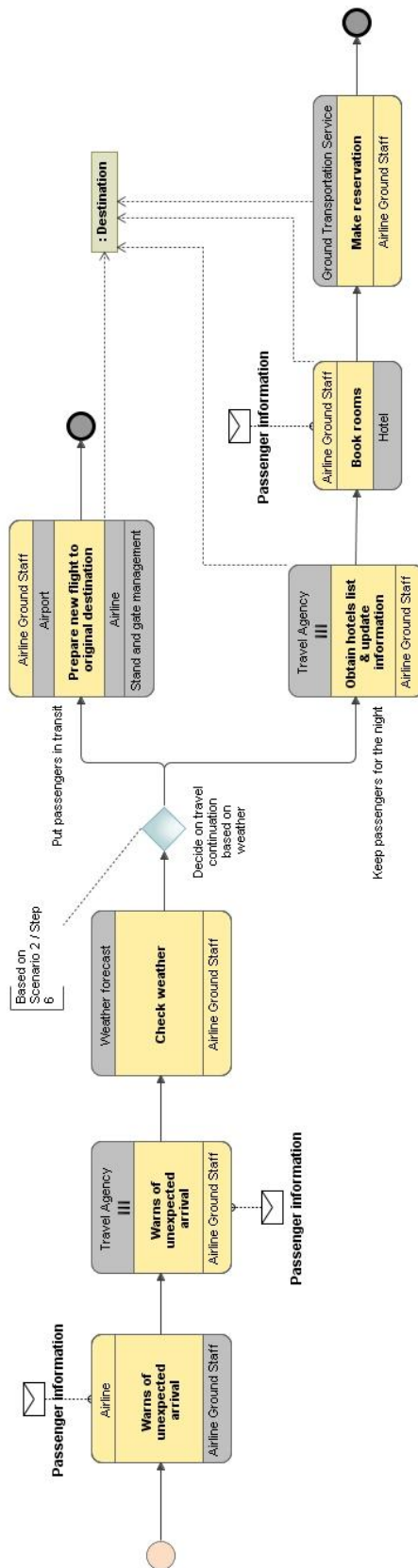


Figure 14 - BPMN diagram of scenario 2 - “Management of unexpected arrival” sub-choreography

6. Glossary

Elicitation	“The discovery, gathering, or ‘capture’ of requirements, often by developing scenarios.”
Functional requirement	Functional requirements define what the system must do in terms of the interaction between the machine and the problem domain, behaviours, functions and services to be provided. Functional requirements are either met or not met by the future system: they cannot be partially met.
Non-functional requirement	Non-functional requirements restrict the types of machine solution (i.e. system) which should be developed. Examples of non-functional requirements are those which relate to maintainability, reliability and usability. A more complete list of non-functional requirement types is given below. Unlike functional requirements, non-functional requirements focus on a whole system rather than its parts, and may not be formalisable.
Requirement	Requirements have variously been defined and described, for example: A requirement is “something that a product must do or a quality that the product must have”. [4]; Requirements are expressions of required phenomena that are shared between a machine (product) and the domain or environment [3]; “Requirements invariably contain a mixture of problem information, statements of system behaviour and properties, and design and implementation constraints” [5]
Requirement type	The CHOReOS use cases use the following requirement types: Functional requirements (FR) Non-functional requirements, including: Accuracy requirements (AcR); Adaptability requirements (AdR); Availability requirements (AvR); Awareness requirements (AwR); Interoperability requirements (IR); Maintainability requirements (MR); Mobility requirements (MoR); Organisational requirements (OR); Performance requirements (PR); Reliability requirements (RR); Scalability requirements (ScR); Security requirements (SR);

	Usability requirements (UR);
Scenario	An instance of a use case, expressed as a sequence of event . Holbatz describes a scenario as a “sequence of steps that defines a task performed to achieve an intent” [2]
Stakeholder	Someone with an interest in the future system who might have requirements on the system.
Step	“An action or event representing an atomic component of a scenario. In a use case, each step is normally described in a separate paragraph of text (...)” [2]

7. References

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- [8] World Business Council for Sustainable Development, ‘Sustainable Consumption Facts and Trends’