



Adaptation of CWP simulator

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SAFELAND

SAFE LANDING THROUGH ENHANCED GROUND SUPPORT

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Abstract

SAFELAND is developing a future concept of operation for single-piloted aircraft, dealing with the problem of pilot incapacitation. The developed concept will be evaluated in a Human-in-the-Loop real time simulation involving Air Traffic Controllers and Airline Pilots in April 2022 at the premises of DLR's Institute of Flight Guidance in Braunschweig, Germany.

This deliverable elaborates the adaptations and modifications made to the Controller Working Position (CWP) simulator that will be used in the SAFELAND simulation. The CWP simulator will be operated by Air Traffic Controllers provided by the partner organisation Luftfartsverket (LFV) of the SAFELAND consortium. Their task will be to experience the developed SAFELAND concept in two different scenarios in which single pilot incapacitation will occur during flight.

This deliverable is marked as type 'Other' and consists of this document and two download links. Via each link a video displaying the CWP operated in the two different SAFELAND scenarios can be downloaded. Each video clarifies the operability of the CWP simulator in the SAFELAND context.

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1 Introduction¹

1.1 Purpose and scope of this document

This deliverable illustrates the adaptation made on the Controller Working Position (CWP) simulator which will be used within the SAFELAND Human-in-the-Loop real time simulation (RTS) at DLR's Institute of Flight Guidance in Braunschweig, Germany. The main purpose of this deliverable is to introduce the reader to the functionalities and operability of the working position for the Air Traffic Controllers (ATCO) in the SAFELAND simulation. This real-time simulation will involve airline pilots (operating a Ground Station), Air Traffic Controllers (operating the CWP), pilots (operating a Cockpit simulator), and potentially pseudo-pilots (controlling surrounding air traffic), and are planned to be conducted in April 2022. Due to the global COVID-19 pandemic, a reduced risk simulation with the relevant actors (i.e. ATCOs, pilots, HF experts, simulation experts, legal and regulatory experts) will be conducted by taking precaution measures (e.g. fully vaccinated, social distancing, wearing masks at all times) into account.

The scope of this deliverable is to visualise the functionalities of the CWP, including the traffic simulator. As this deliverable is marked as type 'Other', it has been agreed to take advantage of screen recording applications in order to show the operability of the CWP within the SAFELAND context. These videos were recorded in January 2022, where DLR employees acted as SP, ACTOs and GSOs. In total, two different SAFELAND scenarios will be simulated, as described in D3.1 (SAFELAND, 2021a). The envisaged structure of both scenarios, and especially the operational steps needed to be performed by the human operator of the CWP are described in section 3.

1.2 Structure of the document

In total, this document consists of 5 chapters, which are further subdivided into subsections. The chapters and their main topics are the following:

- Chapter 1 describes the purpose and scope of this document. Furthermore, it details the structure of the document and provides a list of the used acronyms.
- Chapter 2 provides a preliminary overview of the simulation architecture within SAFELAND in order to illustrate the interconnections of the CWP simulator with the entire simulation infrastructure.
- Chapter 3 details the content of the two recorded videos referring to the pre-defined SAFELAND scenarios as described in deliverable D3.1 (SAFELAND, 2021).
- Chapter 4 provides two links to download the recorded videos of the CWP simulator.

¹ The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein

- Chapter 5 lists the references used in this document.

1.3 List of acronyms

Term	Definition
A/C	Aircraft
ATC	Air Traffic Control
ATCO	Air Traffic Controllers
CWP	Controller Working Position
EDDL	ICAO code of Düsseldorf airport
FMS	Flight Management System
FPL	Flight Plan
GCS	Ground Control Station
GSO	Ground Station Operator
iSIM	Integrated Cockpit Simulator
LFV	Luftfartsverket
PIC	Pilot in Command
RTS	Real-time simulation
SJU	SESAR Joint Undertaking
SP	Single Pilot
SWISS	Swiss International Air Lines
TMA	Terminal Manoeuvring Area
U-FLY	DLRs Remote Cockpit simulator (GCS application)

Table 1: Acronyms

2 Simulator and architecture

This section describes the high-level architecture of the simulation environment for the SAFELAND project. Hereby, this section details the interconnections of the CWP to the traffic simulation *TrafficSim*, to the remote pilot station application *U-FLY*, to the single cockpit simulator *iSIM* and to the data exchange software *datapool*. A more detailed description on the simulation infrastructure will be given in the deliverable D2.4 *Integration Report* (SAFELAND, 2022a).

2.1 CWP

In the context of the SAFELAND RTS, a Controller Working Position (CWP) will be operated by the ATCOs to provide clearance to multiple aircraft as needed, and to follow the air traffic via the radar screen. Figure 1 depicts the generic radar screen environment from the DLR tool platform *Skynet*. During the RTS, licensed ACTOs (LFV employees) will be operating the CWP. A more detailed description on the CWP can be found in deliverable D3.1 (SAFELAND, 2021).



Figure 1. Radar screen of the CWP simulator

The main functionalities of the CWP can be summarised as follows:

- Display and monitor surrounding air traffic
- Overview of air traffic situation in the relevant sector
- Visualisation of actual position of each aircraft in the relevant sector
- Aircraft control (i.e. altitude, heading, speed changes) via datalink (if required)

- Voice communication with pilots via head-set

2.2 Interconnections between the Controller Working Position and the simulation infrastructure

Figures 2 and 3 illustrate the interconnections of the CWP to DLR's simulation infrastructure for both SAFELAND scenarios (cf. chapter 3) in nominal flight conditions and during onboard single pilot incapacitation, respectively.

In general, all simulation tools are interconnected to DLR's data distribution tool *datapool*. *Datapool* is the central communication tool and acts as a server transmitting all messages to the connected clients (here the different simulators). The CWP receives and transfers all its messages via *datapool* to the other actors (i.e. simulators).

The following types of data will be received by the CWP:

- Aircraft State Vectors (ASV)

The following types of data will be transmitted by the CWP:

- (high-level) A/C commands to the surrounding air traffic (if required)

For more details on the data distribution tool *datapool* and on the transmitted messages to/from the CWP, please cf. deliverable D2.4 (SAFELAND, 2022a).

- Legend**
- A/C: Aircraft
 - ASV: Aircraft State Vector
 - ATCO: Air Traffic Controller
 - CWP: Controller Working Position
 - GSO: Ground Station Operator
 - SP: Single Pilot

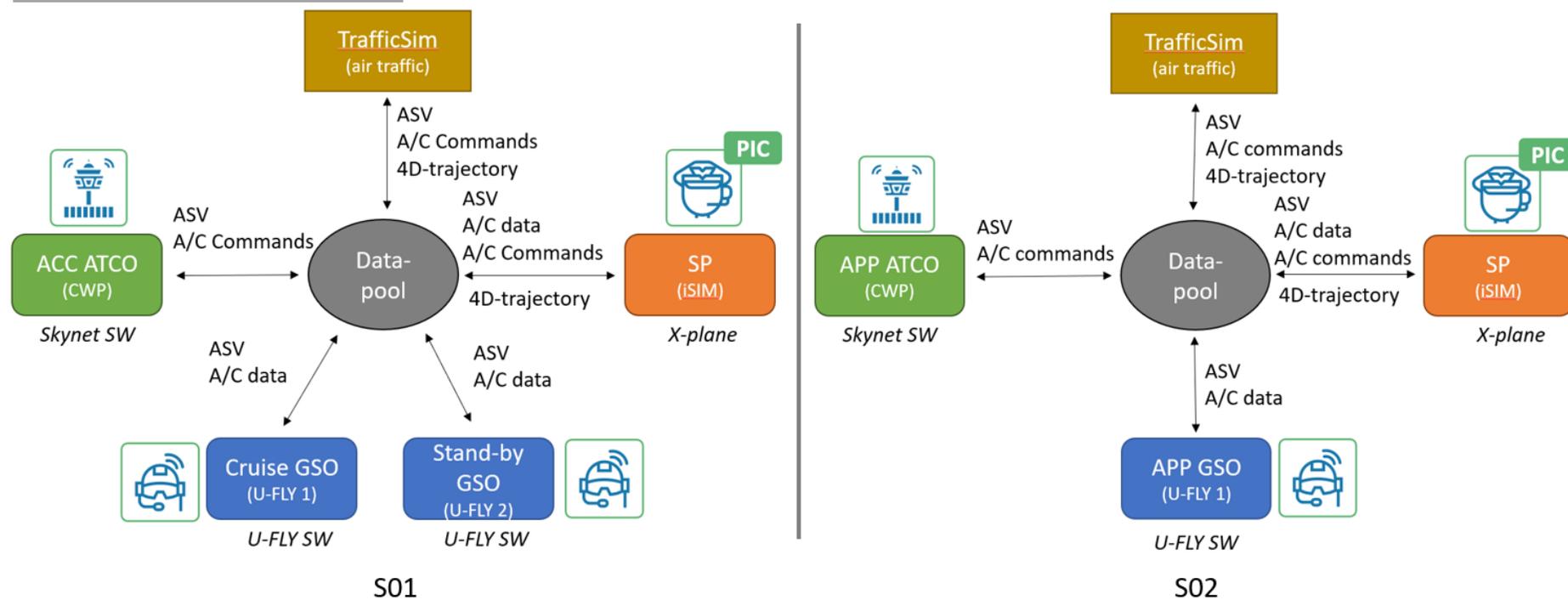


Figure 2. Interconnections of the CWP for nominal flight conditions

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Legend

- A/C: Aircraft
- ASV: Aircraft State Vector
- ATCO: Air Traffic Controller
- CWP: Controller Working Position
- GSO: Ground Station Operator
- SP: Single Pilot

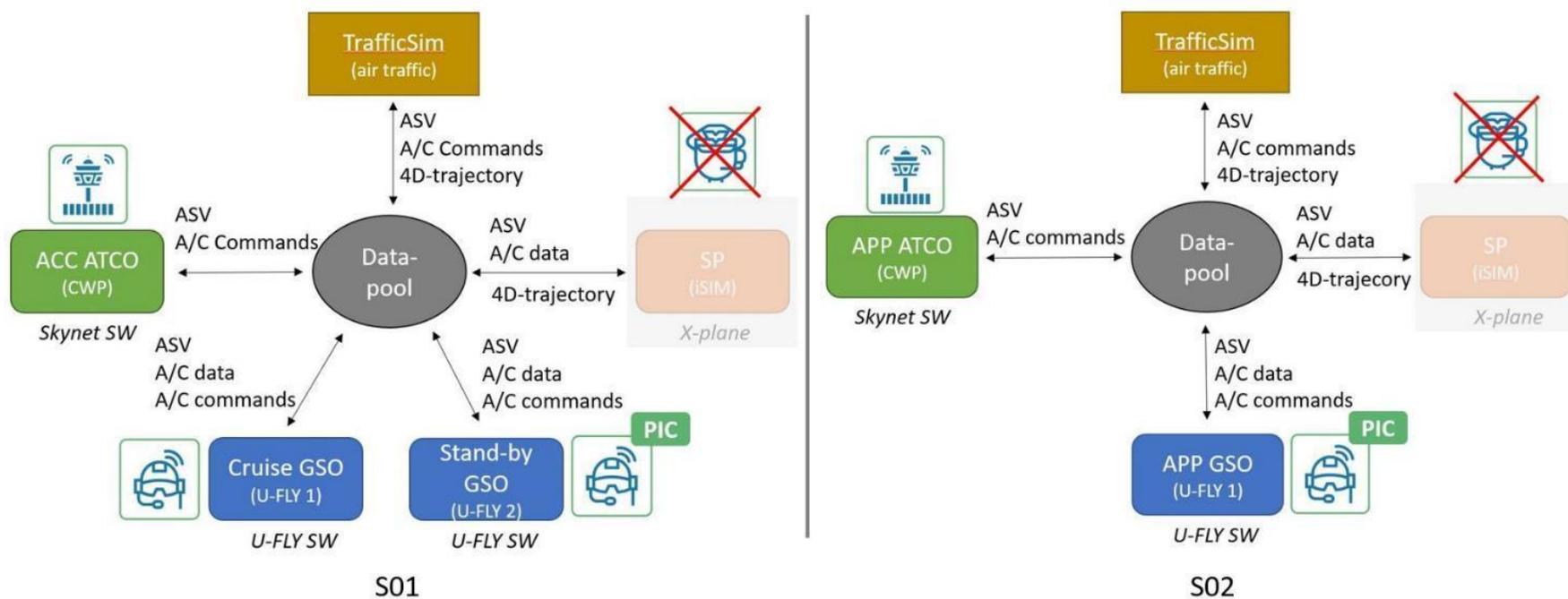


Figure 3. Interconnection of the CWP in case of pilot incapacitation

3 Content of the videos

This section describes the content of the recorded videos. In total, two videos were prepared via screen recording depicting the operator screen of the CWP simulator. The CWP will be operated by a human operator (i.e. licenced ATCO) sitting in front of the radar screen who will be able to control the surrounding air traffic in his/her sector (if needed). In order to address the validation objectives defined to assess the SAFELAND operational concept for single pilot incapacitation, the SAFELAND consortium identified two different scenarios that will be evaluated in Human-in-the-Loop real-time simulation.

In scenario 1 (S01) the onboard single pilot incapacitation will occur during cruise (i.e. en-route phase) above Hungarian airspace whilst an en-route ATCO is monitoring the respective sector. In scenario 2 (S02) pilot incapacitation will occur in the Terminal Manoeuvring Area (TMA) of Düsseldorf airport (EDDL) whilst an approach ATCO is monitoring the relevant sector. More details regarding the overall scenarios and the required operational steps to be performed by the ATCOs will be given in the subsections below. In this document the scenario description focuses on the ATCO perspective and describes the foreseen high-level script for the RTS to be conducted in April 2022. The scenario description in deliverable D2.2 (SAFELAND, 2022a) focuses on the onboard pilot perspective, and the scenario description in deliverable D2.3 (SAFELAND, 2022b) focuses on the GSO perspective.

3.1 S01 – Single Pilot Incapacitation en-route

S01 corresponds to a commercial flight of an Airbus A321 from Zürich (LSZH) to Kiev (UKBB) with passengers on board of the aircraft. The simulated traffic scenario has been adapted for the SAFELAND use-case in S01 from EUROCONTROL's DDR2 traffic data of a normal air traffic day recorded on 29th June 2019. Further, optimal weather conditions (i.e. dry, no wind) can be reported. The SAFELAND simulation starts in the cruise phase at flight level 330 just before the aircraft enters the Hungarian airspace via waypoint *PESAT* from the west. Both the autopilot and the auto throttle are engaged at the start of the scenario, and the aircraft is following the flight plan (FPL) stored in the Flight Management System (FMS) of the aircraft. In the first couple of minutes of the simulation, the onboard single pilot (DLR employee) is able to control and operate the aircraft normally via the cockpit simulator (i.e. iSIM). However, as the aircraft is following the FPL, no further inputs are expected from the pilot. Furthermore, a cruise GSO is monitoring multiple aircraft simultaneously, whereby one of them is the simulated aircraft operated via the iSIM simulator. In addition, an ATCO is monitoring the respective sector of the Hungarian airspace. At this point of the scenario no communication between the actors is expected.

Within the SAFELAND RTS, the onboard pilot incapacitation will be issued through the cockpit simulator by setting the squawk code of the simulated aircraft to 7700 via the touchscreens of the simulator. In a future airline operation, the pilot incapacitation would be recognized by a pilot health monitoring system which is not available in the SAFELAND simulations (and out of scope for the project). The squawk code 7700 indicates pilot incapacitation and will be transmitted to the cruise GSO (for more details cf. D2.3) and announced by the GSO to the en-route ATCO via voice communication. Hereafter, for a short period of time, the aircraft is following the defined FPL and the cruise GSO is asked to take over control of the aircraft after having verified pilot incapacitation. Once pilot incapacitation is confirmed, ATC clears the airspace in the vicinity of the concerned aircraft (if

required). In order to accomplish this task, the ATCO is able to control the surrounding air traffic via the CWP application (if needed). Hereafter, the cruise GSO will hand over the responsibility of controlling the aircraft to a Stand-by GSO (cf. D2.3 for more details) who will become the new Pilot-in-Command (PIC). With the assistance of ATC, the Stand-by GSO will decide for a suitable landing airport. The coordination between the new PIC and the ATCO is expected to be carried out via voice communication. Hereafter, the Stand-by GSO will create a new FPL to the alternate airport, and upload it to the FMS of the aircraft. As soon as the aircraft follows the new FPL, the ACTO is expected to clear the way to the new destination airport (if needed). S01 ends after the new FPL has been sent to the aircraft.

3.2 S02 – Single Pilot Incapacitation in TMA

S02 consists of a commercial flight of an Airbus A321 from Zürich (LSZH) to Düsseldorf airport (EDDL) with passengers on board of the aircraft. The traffic scenario has been constructed based on recorded traffic at EDDL from 2019, with approximately 35 arrival movements per hour and adapted to the SAFELAND use-case in S02. Further, the weather conditions are good (i.e. dry, wind speed: 10kts) and no turbulence is expected. The SAFELAND simulation starts right before the aircraft enters the TMA of EDDL at flight level 120. Shortly after the simulations starts, the onboard pilot (DLR employee with ATPL) will contact Düsseldorf control (i.e. Langen Radar) inbound STAR *DOMUX*. The autopilot is engaged at the start of the scenario and the aircraft is following a defined flight plan (FPL), in which the approach procedures for EDDL are stored. In the first couple of minutes of the simulation, the onboard single pilot (SP) is able to control and operate the aircraft normally via the cockpit simulator (i.e. iSIM). However, within the SAFELAND project it has been agreed that the aircraft is able to land automatically (i.e. via automatic take-off and landing system – ATOL) (SAFELAND, 2021b) where no further inputs are expected from the SP. Furthermore, an approach GSO and an approach ATCO are monitoring the aircraft. At this point of the scenario no communication between the actors is expected.

As in S01, the onboard pilot incapacitation will be triggered through the cockpit simulator by setting the squawk code of the simulated aircraft to 7700 via the touchscreens of the simulator. In a future airline operation, pilot incapacitation would be recognized by a pilot health monitoring system. The squawk code 7700 indicates pilot incapacitation and will be transmitted to the approach GSO and to the approach ATCO. Hereafter, the approach ATCO and the other actors are expected to follow the SAFELAND operational concept for pilot incapacitation. For a short period of time, the aircraft follows the defined FPL, until the approach GSO confirms the pilot incapacitation, and afterwards takes over control of the aircraft, and thereby becoming the new PIC. As soon as pilot incapacitation is confirmed, the ATCO is expected to clear the airspace in the vicinity of the aircraft (if needed). Hereafter, with the assistance of ATC, the approach GSO will have to decide if the aircraft should enter a holding pattern or continue the FPL stored in the FMS of the aircraft. In both cases, the ATCO is expected to clear the airspace for the final approach on EDDL. The coordination between the approach GSO and the ATCO is expected to be carried out via voice communication. As the SAFELAND operational concept is relying on more sophisticated onboard automation, it is expected that the aircraft will land the aircraft automatically (i.e. via an automatic take-off and landing system - ATOL) based on the FPL stored in the FMS of the aircraft. The approach GSO is able to modify the FPL if required. S02 ends with the touchdown on the runway (23L) in EDDL.

4 Download links

This section includes the links to download the recorded videos from a secure server that were recorded in January 2022 with DLR employees acting as SP, ATCO and GSOs. These videos depict one possible way to handle the severe event of single pilot incapacitation in the two situations (i.e. en-route, approach). However, during the SAFELAND RTS in April 2022 the licenced ATCOS (LFV employees) and pilots (SWISS employees) might react differently to the presented event of pilot incapacitation.

4.1 Download link for S01

Please find here the link to download the video for operating the CWP simulator in SAFELAND scenario 1 (S01):

[Download File \(dlr.de\)](#)

4.2 Download link for S02

Please find here the link to download the video for operating the CWP simulator in SAFELAND scenario 2 (S02):

[Download File \(dlr.de\)](#)

5 References

- [1] SAFELAND (2021a). *Preliminary Results*. SAFELAND D3.1.
- [2] SAFELAND (2021b). *Final Concept*. SAFELAND D1.4.
- [3] SAFELAND (2022a). *Adaptation of Cockpit simulator*. SAFELAND D2.2.
- [4] SAFELAND (2022b). *Adaptation of Remote Cockpit simulator*. SAFELAND D2.3.
- [5] SAFELAND (2022c). *Integration Report*. SAFELAND D2.4

