

# SAFELAND Final Evaluation Results: Outcomes and Insights from the Real Time Simulation, and Legal & Regulatory analysis

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### **SAFELAND RTS data gathering**





Observations





#### **Final Debriefing**

#### Questionnaires

### **SAFELAND RTS data**





12<sup>th</sup> EASN, Barcelona, 19/10/2022

#### **Roles and responsibilities - ATCO**



ATCOs rating on **clarity** of roles and responsibilities divided per scenario.

Positive evaluations, no differences between scenarios, low variability in the scores.







#### Acceptability, safety and trust - ATCO

ATCO. Roles, responsibilities, operating methods, safety and trust.



#### **Tasks and procedures - ATCO**





Positive evaluation for the Monitoring, Conflict detection and resolution and Coordination tasks, with low variability among participants. Managing traffic was considered more problematic. ATCO. You were able to perform your tasks as in current operations



A few issues due to

- technical issues experienced
- unfamiliarity with the approach procedures for the Düsseldorf airport.

### **SAFELAND changes: ATCOs**





NO big changes in ATCOs' tasks, procedures and responsibilities compared to current emergency operations.

After incapacitation, the ATCO:

- clears the airspace
- coordinates with any other ATC services/concerned units as needed
- supports the GSO as needed





#### **Roles and responsibilities - GSO**

Pilots rating on **clarity** of roles and responsibilities divided per scenario.

Positive evaluation. Higher variability among participants.

Uncertainty due to the lack of familiarity with SAFELAND procedures and capabilities of the GS. Pilots not always sure of which actions and decisions were within their range of possibility.

GSO ATCO NOC Cruise GSO 1 2 3 4

GSO. Roles and responsibilities were clear

#### TMA average EN-ROUTE average • min and max

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#### Acceptability, safety and trust - GSO



GSO. Roles, responsibilities, operating methods, safety and trust.



■ average ● min and max

Overall, positive evaluation of acceptability of role, clarity and acceptability of procedures.

Less positive evaluation of safety level and trust in the concept.

High variability among participants

### **SAFELAND** changes and challenges: pilots





- New role
  On-board pilot → remote pilot (GSO)
  Two-pilot crew → single remote pilot
- New environment
  Cockpit → Ground Station
- 3. New procedures
- 1. Assumptions (e.g., technology, no delay...)





#### Acceptability, safety and trust - GSO



#### Tasks and procedures - GSO





Navigating and managing were the most affected functions due to:

- New environment (GS)
- Limitations imposed by design (lack manual control)
- New role (single remote pilot)

Communication was effective

GSO. You were able to perform your tasks as in current operations



■ average ● min and max



### **Coordination and Communication – ATCOs and Pilots**



ATCO. The communication was effective, clear, sufficient and on-time, between:



GSO. The communication was effective, clear, sufficient and on-time, between:







### Situational Awareness : Info Type and Quality - ATCOs

ATCOs rating on type and quality of information provided by the different actors during the two scenarios



ATCO. You had all the information you needed to perform your tasks. Information provided by:





#### **Quality of information**

ATCO. The timeliness and accuracy of information received was adequate. Information provided by:









### Additional Tools /improvements - CWP

- Different labels for SP aircraft
- Specific squawk indicating single pilot incapacitation
- System capable of automatically sending operational information (e.g., remaining fuel, number of people on-board) from the aircraft to the CWP.



### Situational Awareness: Info Type and Quality - GSO

Pilots rating on type and quality of information provided by the different actors during the two scenarios





#### **Quality of information**

GSO. The timeliness and accuracy of information received was adequate. Information provided by:



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### **SAFELAND RTS Results Technical Support Systems and HMI - GSO**





**Pilot Health Monitoring system** 







#### **Requirement**:

More information on on-board pilot health status

#### **Possible issues:**

System failure (Late/or no detection/false positives) Subtle incapacitation

#### **Possible mitigations:**

Camera inside the cockpit Shared audio environment Precursors of incapacitation (WL, stress, fatigue) & physio/neuro-physio measurements Combination with rule-based behaviors and interaction with cabin crew



### SAFELAND RTS Results Workload – ATCOs AND Pilots



#### ATCO. Overall workload level





#### GSO. Overall workload level



#### Due to

- missing and limited information provided by the GS
- limited capabilities of the GS
- being alone



ATCO role, responsibilities and procedures did not change much

→ very positive evaluation

**Pilots** faced many changes (in their role, environment, procedures) and challenges (SPO and related technologies not implemented yet).

- → positive evaluation of operating procedures, dynamic of interactions between team members, coordination and communication flow
- → however, feasibility acceptability and trust would depend on future technological implementations, and on reliability and redundancy of the systems in place.



Next research steps to build a framework around the SAFELAND concept, and make the concept itself more robust

- the development of a definitive SPO CONOPS;
- the key technological enablers (airborne, ground side and communication) needed to support SPO preserving the same safety levels of current operations;
- integration and validation of the different architectural and functional components in following maturity phases to uncover procedural gaps/ emerging system properties/ safety issues/ potential barriers.

### **SAFELAND Next steps**



Other open points are:

- Incapacitation detection (failure, false positive, partial incapacitation)
- Transition period from nominal SPO case (on-board pilot in control) and incapacitation confirmation
- Additional use cases (other system failures, latency communications)
- Role of the cabin crew
- Ground station (physical architecture, technical challenges, manpower & personnel, training needed, GS HMI)
- Social and ethical aspects (trust and confidence, acceptability)



### **Open points of discussion:**

#### What should be the competences of a GSO?



Participants were asked to identify what should be **the competences** of a GSO.

Both pilot and ATCO participants agreed that, to ensure a high level of safety, the GSO knowledge, skills and operational experience should be similar to those required for a pilot + specific training to operate remotely from the GS + well trained monitoring skills.

### **Open points of discussion:**



#### Ethical and legal (privacy) issues of the PHM system



Would a system collecting and transferring pilots health data and performance be acceptable?

Would a camera inside the cockpit be acceptable?



# SAFELAND Legal Analysis Results

Francesco Godano (EUI) 12th EASN International Conference, Barcellona, 19 October 2022



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### Legal analysis: design and evaluation



- Legal analysis involved in:
  - > **Design** of the concept and implementation options
  - > Evaluation of the concept
- Principle of "legal co-design of technology" (human-centered approach) enables better regulation, reduces legal risk

### Legal liability and SAFELAND actors



- Focus on responsibility and legal liability of actors involved
  - > No pre-emptive apportion of blame <a>[]</a> enhancing robust system and culture of safety
  - > Appropriate and precise responsibilities 2 reduce liability risk and litigation
- In general: **no significant showstoppers** in terms of liability attribution (procedures, handovers, task allocation)
  - ✓ Role of **ATCO** does not change significantly <sup>□</sup> no increased liability risk
  - ✓ Key point: relation between GSO and Automation: assigning sets of respective responsibilities / liabilities



### Legal liability and the PIC

 Necessary presence of a *human* Pilot-in-command (PIC) to operate any flight (ICAO Convention, Annex 2 Rules of the air, ch. 2.3.1, 2.4; ICAO Manual on RPAS, ch. 9.9.1)

I more general principle of "human-in-control" (EU Regulation Proposal on AI, Art. 14)

- Need to design the GSO role as encompassing all PIC responsibilities
- ...including supervision (monitoring and "overriding" authority) over Automation

### Legal liability, GSO and Automation/1



- Evaluation activities displayed issues of acceptability of GSO tasks and responsibility as a PIC
  - ✓ HMI and reliance on automation: need to understand and trust the system
    - principle of trustworthy Al/automation
  - ✓ Handling emergency procedure without a co-pilot (navigate, manage)
  - ✓ Design of the GS
    - GS flight instruments (stick and rudder, speed breaks)
    - Flight information for GSO (e.g., vertical speed)
    - On-board sensory cues for the GSO

➤ Result in less precise definition of GSO role 🛛 increased liability risk

### Legal liability, GSO and Automation/2



- Conversely: impact on boundaries with responsibilities/liability of Automation
  Requirements, certification systems, "product liability" of manufacturers/maintenance
- More general issue of *reliance on automated systems*
- Out of scope in SAFELAND 2 to be addressed at **further research stages** 
  - ✓ Human-machine interaction: understanding (explainability) and trust in the system
  - ✓ System failures and mitigations

### Human and automation in command?



- Higher degree of Automation? lower degree of control by human (GSO)
- Possible scenario: final authority/responsibility of key tasks on Automation
- Possible need to revise the "human PIC principle" I shared human-machine command of aircraft?
  - > Legally unacceptable today, but research is developing (e.g. self-driving cars)
  - > Need for precise legal definition and requirements
  - Related social acceptability issues (lack of human-in-control), especially relevant in aviation



### **Other legal issues**

- Handover cruise GSO 🛛 stand-by GSO
  - Alternate option: cruise GSO remains with the emergency, leaving remaining monitoring flights to the stand-by GSO
  - reduce handover issues

- GSO employer: possibility of **wet-lease** to smaller airlines
  - No apparent legal problems: normally the lessee airline will take the place of the employer



### **Further legal research**

- GSO/Automation roles
- Automation requirements for regulation
- Liability of automated systems (product liability)
- Human-in-control principle
- Expand topics of research
  - Ethical/privacy issues (e.g. health monitoring system)
  - Employment of personnel
  - > Insurance



# SAFELAND Regulatory aspects Analysis

Pasquale Junior Capasso (EUROUSC litalia) 12th EASN International Conference, Barcellona, 19 October 2022



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### **SAFELAND EVALUATION PROCESS**



- **Step 1 Overview** of EU regulations and related AMC/GM applicable to Single Pilot Operations (SPO)
- Step 2 Identification of main regulatory material which should be amended
- **Step 3** Identification of gaps between current regulation and SAFELAND concept
- Step 4 Definition of possible amendments to AMC/GM to address SAFELAND



### **OVERVIEW OF MAIN REGULATIONS 1/2**



### $\checkmark$ RULES OF THE AIR

 IR (EU) No 923/2012 "common rules of the air and operational provisions regarding services and procedures in air navigation"



### ✓ PERSONNEL LICENSING AND CREW REQUIREMENTS

- Regulation (EU) No 1178/2011 "technical requirements and administrative procedures related to civil aviation aircrew"
- Regulation (EU) No 2015/340 «technical requirements and administrative procedures relating to air traffic controllers' licences and certificates"



### **OVERVIEW OF MAIN REGULATIONS**



### $\checkmark$ AIRCRAFT OPERATIONS

 Regulation (EU) No 965/2012 «technical requirements and administrative procedures related to air operations"



### $\checkmark$ INITIAL AIRWORTHINESS

• CS-25 for large aeroplanes



### **POSSIBLE AMENDMENTS TO AMC/GM**



- Communication, procedures, and urgency signals
- Specific requirements on competency and training of RP/GSO, SP and ATCO
- GS functions: GS crew, security, lease agreements, procedures, environmental requirements, weather display, head-up display, etc.
- Automation and GSO functions: new systems, increased automation functions, GSO workload, C2 link, procedures, etc.

The proposed changes should be consistent with ICAO Amdt 175 Annex 1, (applicable November 2022), on Remote Pilot involved in IFR flights even if Annex 1 is not aimed to carriage of passengers



### **SENSITIVE ISSUES**

- Role and competency of SP (before full incapacitation)
- Role and competency of GSO (for Certified UAS operations)
- Role and competency of ATCO (after full incapacitation)
- Role of the Operator
- Regulatory aspects influenced by level of automation



#### **RMT.0595**

theoretical knowledge syllabi, learning objectives, and examination procedures for ATPL, MPL, CPL, and IR

#### **RMT.0230**

rules for the operation of UAS and for UAM in the EU

**RMT.0476** SERA (IR/AMC/GM)

**RMT.0392** air operations rules

**RMT.0196** FSTD requirements



# THANK YOU FOR YOUR ATTENTION

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 890599



Co-funded by the European Union

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