UAS Flight Authorisation Automated Testing

Date:	27/06/2022
To:	To Whom It May Concern

File: BAZL-014-1/2/8/3/1

UAS Flight Authorisation Automated Testing

1.1 Executive summary

In late August 2021, the Swiss U-space Implementation (SUSI)[1] partnership started working on the implementation of the UAS flight authorisation service as described by Article 10 of the Implementing Regulation (EU) 2021/664[2]. Upon completion of the technical infrastructure required to exchange UAS flight authorisation data amongst U-space service providers (USSP), it became clear that their manual onboarding and the service's continuous oversight would not be sustainable in the long term in terms of resources for the Federal Office of Civil Aviation (FOCA). A manual process would also have limited the U-space Service Providers' (USSPs) ability to innovate due to difficulties in getting changes tested and approved rapidly. The following sections describe the iterative approach undertaken by a SUSI working group to establish an automated onboarding and oversight framework.

1.2 Incremental approach to develop the automated testing

SUSI members were able to leverage previous experience with automated software testing in the framework of the network remote identification implementation[3]. In October 2021, the working group successfully conducted a technical and operational test[4] of the UAS flight authorisation service described in the Implementing Regulation (EU) 2021/664 using the ASTM F3548-21 Standard[5]. The working group's next action was to develop an approach to continuously test the participating USSPs' ability to meet the requirements set in the standard.

The initial step consisted in performing a manual checkout process based on operational scenarios. It involved a staging environment (configured in a similar manner to the expected production environment) in which all the participants were required to configure and maintain the service. In the course of a one-hour session, participants were successively asked to submit flight

---

[1] susi.swiss

[2] eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021R0664

[3] Switzerland Launches First Nationwide Network Remote Identification Service For Drones

[4] Operator Experience Journey – SUSI

[5] Standard Specification for UAS Traffic Management (UTM) UAS Service Supplier (USS) Interoperability (astm.org)

authorisation requests according to a scripted test sequence in order to validate the integration between all the services. The results were positive in the sense that all three participating USSPs were able to meet the test objectives and pass the manual checkouts. This approach, however, was very expensive in terms of human resources and would not be suited to an increased number of participants. In practice, each time a participant wanted to make a change, they would have to go through the checkout process again. The manual checkout also limited the amount of tests that could be performed, thus limiting their coverage.

In April 2022, the InterUSS Platform[6] introduced an open-source automated testing framework for the UAS flight authorisation service, enabling any interested USSPs to run the onboarding process by themselves. FOCA actively contributes to the development of the testing framework by submitting code, conducting reviews and contributing to the development to ensure compatibility with the U-space Regulation. The framework can be understood as a form of digital flight director (called test driver) that submits operational intents and other data as mandated by the regulation to the participating USSP. To allow the test driver to submit flights, participants are required to implement a dedicated standard interface, which is also specified[7]. They can then translate the operational intents into their proprietary data models internally within their systems. Each participant is required to maintain a system identical to the one running in their production environment. This environment is used for interoperability testing, and allows new participants to test their infrastructure against that of existing participants without having an impact on live operations.

The current version of the framework covers the following test scenarios:

- Nominal strategic coordination (ASTM F3548-21) with equal and different priorities: In these scenarios, the test driver injects flights into the system using the standardised test interface. It then checks the USSPs' responses to ensure that conflicting operations are correctly identified. Then it queries the Discovery and Synchronisation service (DSS)[8] to ensure that the USSPs' operations have been successfully submitted for discovery. It also provides a distributed mechanism to ensure that the information they use to make decisions for strategic coordination is complete when performing and communicating updates about their operational intents.
- Data format validation as required by Article 6(4) and Annex IV of the Implementing Regulation (EU) 2021/664: This test validates that the USSP only accepts valid data formats for the fields required by the regulation.

The testing framework is continuously being improved and the analysis of the requirements coverage is published in the InterUSS code repository[9].

In March 2022, FOCA conducted an automated checkout using the testing framework to check the USSPs' ability to meet the data-exchange requirements set in the U-space regulatory

---

[6] https://interussplatform.org/

[7] https://github.com/interuss/dss/tree/master/interfaces/automated-testing/scd

[8] The DSS requirements are defined in the ASTM F3548-21 standard

[9] https://github.com/interuss/dss/tree/master/interfaces/automated-testing/scd/design#coverage

package. Access to the staging environments was granted by FOCA through an authorisation service. No human coordination was required to check out the new participant. FOCA received a report containing all the information required to assess the ability of the new participant to join the production environment. The report included the test configuration, test target version, test driver version, requests traces and the list of issues the test driver may encounter while submitting requests or inconsistencies in the system during the test sequence.

1.3 Continuous oversight

It is expected that for each new version of a participant's system, the test will be run first in their software delivery process and in the staging environment before going into production. To assess the reliability of the distributed system end to end, the test should be run periodically (for instance every 6 hours) in the staging environment. The objective is to highlight issues related to connectivity, infrastructure and in general operations not directly linked with the software itself but which could go unnoticed in a single-point-in-time experiment. The USSPs are expected to inform FOCA of any issues with their tests and to keep the reports for a certain period of time (to be defined; for instance, 3 months). This process will support the resolution of issues with the service and, when required, audits of the USSPs by FOCA.

1.4 Future work

- A web interface is currently under development to facilitate running checkouts and to generate reports.

- A review mechanism could be introduced to manage programmatically the list of participants.

- Currently, the test framework covers nominal strategic coordination (ASTM F3548-21), including the priorities, and validates flight request information as required by Article 6(4) and Annex IV of the Implementing Regulation (EU) 2021/664. More complex scenarios and increased test coverage, including non-nominal use cases, should be implemented.

1.5 Appendix 1

Extract of a sample report injecting a flight from USS-1 to USS-2 and validation of the result by querying the DSS.

General information about the test framework and its configuration, namely the target USSPs and DSS to test.	```{
"qualifier_version": "interuss/uss_qualifier/v0.0.0-bb41b2a",
"configuration": {
"injection_targets": [
{
"name": "USS-1",
"injection_base_url": "https://ussp-1.example.com/api/scd"
},
{
"name": "USS-2",
"injection_base_url": "https://ussp-2.example.com/api/scd"
},
...
],
``

```
      "dss_base_url": "https://test.dss.swissuspace.ch"

},
```

Targets' information retrieved at the beginning of the test to assess the USSP's capabilities.	```\n"targets_information": {\n\n "USS-1": {\n\n "version": "Not specified",\n\n "capabilities": [\n\n "FlightAuthorisationValidation",\n\n "BasicStrategicConflictDetection",\n\n "HighPriorityFlights"\n\n]\n\n },\n\n ...\n\n},\n```
This section gathers all the interactions made by the test driver, including request and response traces, as well as the context of the interaction.	```\n"findings": {\n\n "interactions": [\n\n {\n```

```
                              "interaction_id": "9f73e493-e16a-4db3-9f71-734a39f5364c",

                              "purpose": "Inject flight into USS",

                              "test_step": {

                                   "name": "Inject flight via First-mover USS",

                                   "index": 0,

                                   "phase": "Test"

                              },

                              "context": {

                                   "test_id": "astm-strategic-coordination/nominal-planning-
priority-1",

                                   "test_name": "Nominal Planning Test with Priority",

                                   "locale": "CHE",

                                   "targets_combination": {

                                        "First-Mover USS": "USS-1",

                                        "Second USS": "USS-2"

                                   }

                              },

                              "query": {

                                   "request": {

                                        "method": "PUT",
```

```
                                    "url": "https://ussp-
1.example.com/api/scd/v1/flights/d8829bb7-7103-4b5b-aa15-2fade088cea9",

                                    "initiated_at": "2022-05-10T14:31:18.536134",

                                    "headers": {

                                        "User-Agent": "python-requests/2.25.1",

                                        "Accept-Encoding": "gzip, deflate",

                                        "Accept": "*/*",

                                        "Connection": "keep-alive",

                                        "Content-Length": "3766",

                                        "Content-Type": "application/json",

                                        "Authorization": "Bearer [REDACTED]"

                                    },

                                    "json": {

                                        "operational_intent": {

                                            "volumes": [

                                                {

                                                    "volume": {

                                                        "outline_polygon": {

                                                            "vertices": [

                                                                {
```

```
                                    "lat":
46.97491999984008,

                                    "lng":
7.477423822749622

                                },

                                ...

                            ]

                        },

                        "altitude_lower": {

                            "value": 605.0,

                            "reference": "W84",

                            "units": "M"

                        },

                        "altitude_upper": {

                            "value": 635.0,

                            "reference": "W84",

                            "units": "M"

                        }

                    },

                    "time_start": {
```

```
                                    "value": "2022-05-
10T14:39:18.524546Z",

                                    "format": "RFC3339"

                                },

                                "time_end": {

                                    "value": "2022-05-
10T14:44:18.524546Z",

                                    "format": "RFC3339"

                                }

                            }

                        ],

                        "state": "Accepted",

                        "off_nominal_volumes": [],

                        "priority": 0

                    },

                    "flight_authorisation": {

                        "uas_serial_number": "1AF49UL5CC5J6K",

                        "operation_category": "Open",

                        "operation_mode": "Vlos",

                        "uas_class": "C0",
```

```
                                            "identification_technologies": ["ASTMNetRID"],

                                            "connectivity_methods": ["cellular"],

                                            "endurance_minutes": 30,

                                            "emergency_procedure_url":
"https://uav.com/emergency",

                                            "operator_id": "CHEo5kut30e0mt01-qwe",

                                            "uas_id": "",

                                            "uas_type_certificate": ""

                                    }

                                }

                        },

                        "response": {

                            "code": 200,

                            "headers": {

                                "Server": "nginx/1.14.0 (Ubuntu)",

                                "Date": "Tue, 10 May 2022 14:31:21 GMT",

                                "Content-Type": "application/json",

                                "Transfer-Encoding": "chunked",

                                "Connection": "keep-alive",

                                "Access-Control-Allow-Origin": "*"
```

```
                                        },

                                        "elapsed_s": 2.569855,

                                        "reported": "2022-05-10T14:31:21.126331",

                                        "json": {

                                            "result": "Planned",

                                            "operational_intent_id": "0d49838b-0d86-4991-aaaf-
27cca1ac4593"

                                        }

                                    }

                                }

                            },

                            {

                                "interaction_id": "49659adc-6ca0-47d9-a2ed-6b8a98484b81",

                                "purpose": "Check if injected operational intent exists in
DSS",

                                "test_step": {

                                    "name": "Inject flight via First-mover USS",

                                    "index": 0,

                                    "phase": "Test"

                                },
```

```
                       "context": {

                            "test_id": "astm-strategic-coordination/nominal-planning-
priority-1",

                            "test_name": "Nominal Planning Test with Priority",

                            "locale": "CHE",

                            "targets_combination": {

                                "First-Mover USS": "USS-1",

                                "Second USS": "USS-2"

                            }

                       },

                       "query": {

                            "request": {

                                "method": "POST",

                                "url":
"https://test.dss.swissuspace.ch/dss/v1/operational_intent_references/query",

                                "initiated_at": "2022-05-10T14:31:21.136010",

                                "headers": {

                                    "User-Agent": "python-requests/2.25.1",

                                    "Accept-Encoding": "gzip, deflate",

                                    "Accept": "*/*",
```

```
                              "Connection": "keep-alive",

                              "Content-Length": "579",

                              "Content-Type": "application/json",

                              "Authorization": "Bearer [REDACTED]"

                        },

                        "json": {

                              "area_of_interest": {

                                    "volume": {

                                          "outline_polygon": {

                                                "vertices": [

                                                      {

                                                            "lat": 46.974785040181715,

                                                            "lng": 7.477423821039847

                                                      },

                                                      {

                                                            "lat": 46.97551995980457,

                                                            "lng": 7.477423821039847

                                                      },

                                                      {
```

```
                        "lat": 46.97551995980457,

                        "lng": 7.478254178987183

                    },

                    {

                        "lat": 46.974785040181715,

                        "lng": 7.478254178987183

                    }

                ]

            },

            "altitude_lower": {

                "value": 605.0,

                "reference": "W84",

                "units": "M"

            },

            "altitude_upper": {

                "value": 635.0,

                "reference": "W84",

                "units": "M"

            }
```

```
                },

                "time_start": {

                    "value": "2022-05-10T14:39:18.524546Z",

                    "format": "RFC3339"

                },

                "time_end": {

                    "value": "2022-05-10T14:44:18.524546Z",

                    "format": "RFC3339"

                }

            }

        }

    },

    "response": {

        "code": 200,

        "headers": {

            "content-type": "application/json",

            "grpc-metadata-content-type": "application/grpc",

            "grpc-metadata-date": "Tue, 10 May 2022 14:31:23
GMT",

            "grpc-metadata-server": "envoy",
```

```
                                  "grpc-metadata-x-envoy-upstream-service-time":
"11",

                                  "date": "Tue, 10 May 2022 14:31:23 GMT",

                                  "content-length": "611",

                                  "x-envoy-upstream-service-time": "18",

                                  "server": "istio-envoy"

                       },

                       "elapsed_s": 2.590141,

                       "reported": "2022-05-10T14:31:24.199481",

                       "json": {

                            "operational_intent_references": [

                                 {

                                      "id": "0d49838b-0d86-4991-aaaf-
27cca1ac4593",

                                      "manager": "90496F70-7E6D-4913-9514-
FF2C60E250A6@clients",

                                      "ovn": "Available from USS",

                                      "state": "Accepted",

                                      "subscription_id": "548d5cfe-972f-4282-
87de-97942630efe5",

                                      "time_end": {
```

```
                                          "format": "RFC3339",

                                          "value": "2022-05-10T14:44:18.524Z"

                                      },

                                      "time_start": {

                                          "format": "RFC3339",

                                          "value": "2022-05-10T14:39:18.524Z"

                                      },

                                      "uss_availability": "Unknown",

                                      "uss_base_url": "https://ussp-
1.example.com/",

                                      "version": 1

                                  }

                              ]

                          }

                      },

                      "entity_type": "operational_intent_references"

                  }

              },

              ...

          ],
```

| File: BAZL-014-1/2/8/3/1 | ```json
      "issues": []

  }

}
``` |