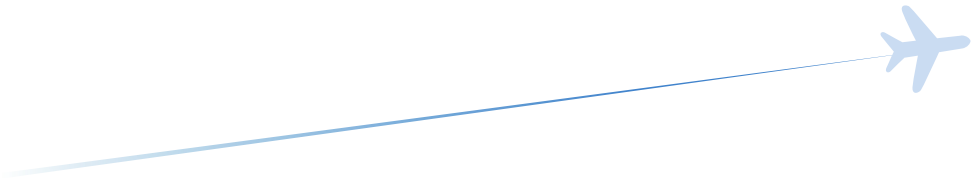

GOF2.0 D2.4 – Appendix F Traffic Conformance Monitoring Exchange Service Specification

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Authoring & Approval

Authors of the document

Name/Beneficiary	Position/Title	Date
Pradyumna Vyshnav / Unmanned Life	WP2	26.4.2021
Shengnan Gao / EHANG	WP2	26.4.2021
Hui Zeng / EHANG	WP2	26.4.2021
Juha Lindstedt / Aviamaps	WP2	26.4.2021
Jose Ignacio Rodriguez / EHANG	WP2	26.4.2021
Ada Lu / EHANG	WP2	26.4.2021
Yuhang Yun / EHANG	WP2	26.4.2021
Piotr Luboński / PSNC	WP2	26.4.2021
Damian Soliwoda / PSNC	WP2	26.4.2021
Sven Jürgenson / Threod	WP2	26.4.2021
Piotr Dybiec / DroneRadar	WP2	26.4.2021
Thomas Wana / Dimetor	WP2	26.4.2021
Tanel Järvet / CAFA Tech	WP2	26.4.2021
Parmentier Remy / Vaisala	WP2	26.4.2021
Piotr Szymaniak / PSNC	WP2	26.4.2021
Pawel Korzec / DroneRadar	WP2	26.4.2021
Lukasz Gorny-Zajac / Droneradar	WP2	26.4.2021
Gokul Srinivasan / Robots Expert	WP2	26.4.2021
Thomas Lutz / Frequentis	WP2 Lead	26.4.2021
Hubert Künig / Frequentis	WP2	26.4.2021
Peter Cornelius / Frequentis	WP2	26.4.2021
Gregor Mogeritsch / Frequentis	WP2	26.4.2021

Name/Beneficiary	Position/Title	Date
Shengnan Gao / EHANG	WP2	26.4.2021
Hui Zeng / EHANG	WP2	26.4.2021
Juha Lindstedt / Aviamaps	WP2	26.4.2021
Jose Ignacio Rodriguez / EHANG	WP2	26.4.2021
Ada Lu / EHANG	WP2	26.4.2021
Yuhang Yun / EHANG	WP2	26.4.2021

Piotr Luboński / PSNC	WP2	26.4.2021
Damian Soliwoda / PSNC	WP2	26.4.2021
Sven Jürgenson / Threod	WP2	26.4.2021
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Gokul Srinivasan / Robots Expert	WP2	26.4.2021
Thomas Lutz / Frequentis	WP2 Lead	26.4.2021
Hubert Künig / Frequentis	WP2	26.4.2021
Peter Cornelius / Frequentis	WP2	26.4.2021
Gregor Mogeritsch / Frequentis	WP2	26.4.2021

Reviewers internal to the project

Name/Beneficiary	Position/Title	Date
Annely Aasalaid / EANS	WP2	29.4.2021
Heikko Jae / EANS	WP2	29.4.2021
Aigar Tarre / EANS	WP2	29.4.2021
Imre Rammul / EANS	WP2	29.4.2021
Armin Sutter / EANS	WP2	29.4.2021
Mateusz Kotliński/PANSA	WP2	29.4.2021
Mateusz Zych/PANSA	WP2	29.4.2021
Thomas Neubauer/Dimetor	WP2	29.4.2021
Sami Alkula / Fintraffic	WP2	29.4.2021
Nunzio Sciammetta / Airbus	WP2	29.4.2021
Maxime Meijers / Airbus	WP2	29.4.2021
Felix Lee/Ehang	WP2	29.4.2021

Approved for submission to the SJU By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date

Rejected By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date

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GOF2.0

GOF2.0 INTEGRATED URBAN AIRSPACE VLD

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Figure 1

Abstract

This specification introduces a service of a Common Information Service (CIS) which ensures interoperability and hence transparent and reliable information flow between the stakeholders in an operational U-space environment. In accordance with ICAO SWIM, represents an Information Exchange Service.

This document describes one of these Bridge Services, the Traffic Conformance Monitoring Exchange service in a logical, technology-independent manner.

Table of Contents

1 Introduction

1.1 Purpose of the document

Based on the guidelines given in [GOF1-Arch-AppA], this document describes the TrafficConformanceMonitoring exchange service of a Common Information Service (CIS) in a logical technology-independent manner, that is:

- operational and business context of the service
  - requirements for the service, e.g. information exchange requirements
  - involved nodes: which operational components provide/consume the service
  - operational activities supported by the service
  - relation of the service to other services
- service description
  - service interface definitions
  - service interface operations
  - service payload definition
  - service dynamic behaviour description
- service provision and validation aspects

In addition, this document clearly defines the version of the service.

1.2 Scope

This document describes the TrafficConformanceMonitoring Exchange service for a CIS.

The TrafficConformanceMonitoring service provides a means for the operational nodes of the U-space to exchange conformance-related target information and make it available for further processing.

1.3 Target Group

This service specification is written for:

- service architects,
- system engineers and
- developers in charge of designing and developing an instance of the TrafficConformanceMonitoring service.

In addition, this service specification is written for:

- enterprise architects,
- service architects,
- information architects,
- system engineers and developers in pursuing architecting, design and development activities of other related services.

1.4 Background

1.4.1 EUROCONTROL Specification for Monitoring Aids (MONA)

EUROCONTROL MONA [EC-MONA] defines conformance monitoring as follows.

"2.2. Conformance Monitoring

The conformance monitoring function compares the system tracks with the corresponding flight clearances in order to warn the controller of any deviation of a flight from its clearance and, where possible, to establish the progress of the flight and to refine the prediction of the remaining trajectory to be flown.

Conformance is monitored in three dimensions, though the monitoring performed varies according to the type of clearance issued. In principle, warnings of deviation are generated in cases where the controller might be required to act to re-clear an aircraft that is assumed to be deviating from its clearance or to re-coordinate an aircraft whose boundary estimate changes significantly.

The [TP-SPEC] defines a planned trajectory and a tactical trajectory. Where possible, the system recalculates the trajectories that are active for a flight according to the actual behaviour of the aircraft, as described below.

..."

1.4.2 EUROCONTROL Safety Nets, A Guide for Ensuring Effectiveness

To ATM automation systems, EUROCONTROL applies such conformance monitoring aids in the form of so-called ground-based safety nets which have been shown to very significantly improve ATM safety [EC-SN-Guide]:

"What are safety nets?

Even the safest systems fail. Safety nets help prevent imminent or actual hazardous situations from developing into major incidents or even accidents. In doing so, they provide additional safety barriers in the overall system. In addition, they help keep the societal outcome of aviation operations within acceptable limits.

In Professor James Reason's Swiss Cheese Model, safety nets are the last system safety defences against accidents. They are intended to provide timely alerts to air traffic controllers or pilots of an increased risk to flight safety. As the impact of accidents in aviation is high, multiple system safety defences are provided, including redundant safety nets.

Safety nets are either ground-based or airborne:

Ground-based safety nets are an integral part of the ATM system. Primarily using ATS surveillance data, they provide warning times of up to two minutes.

Upon receiving an alert, air traffic controllers are expected to immediately assess the situation and take appropriate action.

Airborne safety nets provide alerts and resolution advisories directly to the pilots. Warning times are generally shorter, up to about 40 seconds. Pilots are expected to immediately take appropriate avoiding action.

Airborne safety nets are covered only in terms of their interactions with ground systems. ..."

"... Safety nets are there to provide an additional safety margin on top of the inherently safe provision of ATS and aviation operations. They have been demonstrated to deliver additional risk reduction of up to a factor of ten if implemented and operated appropriately. ..."

1.4.3 EUROCONTROL Concept of Operations for U-space (CORUS)

EUROCONTROL CORUS [CORUS] Vol. 2 elaborates in 5.1.6.1 Monitoring service as follows.

"5.1.6.1 Monitoring service

Subject to appropriate data-quality requirements, this service retrieves data from the tracking service and combines it with information related to non-cooperative obstacles and vehicles to provide an air situation status report for authorities, service providers, and operators, including pilots. This service may include operation plan conformance monitoring, geo-fence compliance monitoring and warnings (see 5.1.2.2), weather limit compliance monitoring, ground risk compliance monitoring, electromagnetic risk monitoring. The geo-fence compliance monitoring and warnings constitute U-space providing Geo-Awareness.

..."

1.4.4 International Civil Aviation Organization (ICAO)

ICAO Doc 10039 [ICAO-SWIM] elaborates in section **3.4 INFORMATION EXCHANGE SERVICES** on information exchange services as follow (para. 3.4.2).

"Within the SWIM Global Interoperability Framework, the Information Exchange layer is instantiated by 'information services' as is further explained. Information services* ensure interoperability *between ATM applications which consume and* provide interoperable information services*. Consequently, the concept of information service is a fundamental building block of SWIM which enables interoperability through well-defined information exchanges."

1.4.5 Open Drone ID

Open Drone ID is a project to provide a low cost and reliable "beacon" capability for drones so that they can be identified when within range of a receiver. Open Drone ID receives support from large companies such as Intel.

The Open Drone ID Message Specification [INTEL-ODID] proposes a Location Message in both, a byte and a JSON representation, which permits the transport of:

- a position in three space dimensions,
- a velocity, and
- a data age.

The Open Drone ID Message Specification furthermore proposes messages to convey information about:

- the type of drone,
- its in-flight status, and
- the location of the drone operator.

1.4.6 SESAR-JU

The European Commission identifies an increasing demand for a non-segregated use of airspace which is being driven by a rapidly growing market of EVery-Low-Level (VLL) airspace users, most of which are expected to be drones.

Via the Roadmap for the safe integration of drones into all classes of airspace [EATMP-Drone], within the European ATM Masterplan [EATMP], the European Commission seeks to ensure that this rapid growth of airspace use happens in a safe and controlled manner.

SESAR develops the required concepts and demonstrations for this process to happen. The roadmap [EATMP-Drone], in alignment with ICAO recommendations, identifies three phases for the integration, from which SESAR derives the four U-space service blocks presented in the U-space blueprint [UspaceBlueprint],

U1 U-space foundation services,

U2 U-space initial services,

U3 U-space advanced services, and

U4 U-space full services.

These stages reflect the anticipated quick growth of demand for U-space services. The state of the art has been, and is being, validated throughout Europe via several Very Large Demonstrator (VLD) projects such as the GOF USPACE project.

During the U1 phases, SESAR expects drones capable to supply their position via telemetry. The U1 and U2 blocks are anticipated to provide tracking capabilities and services.

1.4.7 Efficient, Safe and Sustainable Traffic at Sea (EfficienSea2)

The design method and terminology builds on experience from the EfficienSea2 project [EfficienSea2], [IALA-ENAV].

1.5 Glossary of Terms

Term	Definition
AIR-REPORT	Report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting
External Data Model	Describes the semantics of the domain (or a significant part thereof) by defining data structures and their relations. This could be at logical level (e.g., in UML) or at physical level (e.g., in XSD schema definitions), as for example standard data models.
Message Exchange Pattern	Describes the principles how two different parts of a message passing system (in our case: the service provider and the service consumer) interact and communicate with each other. Examples: In the Request/Response MEP, the service consumer sends a request to the service provider in order to obtain certain information; the service provider provides the requested information in a dedicated response. In the Publish/Subscribe MEP, the service consumer establishes a subscription with the service provider in order to obtain certain information; the service provider publishes information (either in regular intervals or upon change) to all subscribed service consumers.
Operational Activity	Activity performed by an operational node. Examples of operational activities are: Route Planning, Route Optimization, Logistics, Safety, Weather Forecast Provision, …
Operational Model	Structure of operational nodes and associated operational activities and their inter-relations in a process model.
Operational Node	Logical entity that performs activities. Note: nodes are specified independently of any physical realisation. Examples of operational nodes are: Control Center, Authority, Weather Information Provider, …
Service	Provision of something (a non-physical object), by one, for the use of one or more others, regulated by formal definitions and mutual agreements. Services involve interactions between providers and consumers, which may be performed in a digital form (data exchanges) or through voice communication or written processes and procedures.
Service Consumer	Service consumer uses service instances provided by service providers.
Service Data Model	Formal description of one dedicated service at logical level. The service data model is part of the service specification. Is typically defined in UML and/or XSD. If an external data model exists (e.g., a standard data model), then the service

	data model shall refer to it: each data item of the service data model shall be mapped to a data item defined in the external data model.
Service Design Description	Specifies the details of a service technical design (most likely documented by the service implementer). The service design description includes (but is not limited to) a service physical data model and describes the used technology, transport mechanism, quality of service, etc.
Service Implementation	Provider-side implementation of a dedicated service technical design, i.e. implementation of a dedicated service in a dedicated technology
Service Implementer	Implementers of services from the service provider side and/or the service consumer side
Service Instance	One service implementation can be deployed at several places by same or different service providers; each such deployment represents a different service instance, being accessible via different URLs.
Service Instance Description	Documents the details of a service implementation (most likely documented by the service implementer) and deployment (most likely documented by the service provider). The service instance description includes (but is not limited to) service technical design reference, service provider reference, service access information, service coverage information, etc.
Service Interface	Communication mechanism of the service, i.e. interaction mechanism between service provider and service consumer. A service interface is characterised by a message exchange pattern and consists of service operations that are either allocated to the provider or the consumer of the service.
Service Operation	Functions or procedure which enables programmatic communication with a service via a service interface.
Service Physical Data Model	Describes the realisation of a dedicated service data model in a dedicated technology. This includes a detailed description of the data payload to be exchanged using the chosen technology. The actual format of the service physical data model depends on the chosen technology. Examples may be WSDL and XSD files (e.g., for SOAP services) or swagger (Open API) specifications (e.g., for REST services). If an external data model exists (e.g., a standard data model), then the service physical data model shall refer to it: each data item of the service physical data model shall be mapped to a data item defined in the external data model. In order to prove correct implementation of the service specification, there shall exist a mapping between the service physical data model and the service data model. This means, each data item used in the service physical data model shall be mapped to a corresponding data item of the service data model. (In case of existing mappings to a common external (standard) data

	model from both the service data model and the service physical data model, such a mapping is implicitly given.)
Service Provider	A service provider gives instances of services according to a service specification and service instance description. All users within the domain can be service providers, e.g., authorities, organizations (e.g., meteorological), commercial service providers, etc.
Service Specification	Describes one specific service at logical level. The Service Specification is technology-agnostic. The Service Specification includes (but is not limited to) a description of the Service Interfaces and Service Operations with their data payload. The data payload description may be formally defined by a Service Data Model.
Service Specification Producer	Producers of service specifications in accordance with the service documentation guidelines.
Service Technical Design	Technical design of a dedicated service in a dedicated technology. One service specification may result in several technical service designs, realising the service with different or same technologies.
Service Technology Catalogue	List and specifications of allowed technologies for service implementations. Currently, SOAP and REST are envisaged to be allowed service technologies. The service technology catalogue shall describe in detail the allowed service profiles, e.g., by listing communication standards, security standards, stacks, bindings, etc.
Spatial Exclusiveness	A service specification is characterised as “spatially exclusive”, if in any geographical region only one service instance of that specification is allowed to be registered per technology. The decision, which service instance (out of a number of available spatially exclusive services) shall be registered for a certain geographical region, is a governance issue.

Table 1: Glossary of Terms

1.6 List of Acronyms

Acronym	Definition
API	Application Programming Interface
CIS	Common Information Services
MEP	Message Exchange Pattern
NAF	NATO Architectural Framework

REST	Representational State Transfer
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SSD	Service Specification Document
UML	Unified Modelling Language
URL	Uniform Resource Locator
WSDL	Web Service Definition Language
XML	Extendible Mark-up Language
XSD	XML Schema Definition

Table 2: List of Acronyms

2 Service Identification

This chapter gives a unique identification of the service and describes where the service is in terms of the engineering lifecycle.

Name	TrafficConformanceMonitoring Exchange Service
ID	urn:frequentis:services:TrafficConformanceMonitoringExchangeService
Version	1.0
Description	A service which exchanges Traffic Conformance Monitoring warnings about tracks of objects such as aircraft (manned and unmanned)
Keywords	TrafficConformanceMonitoring Service, U-space Tracking, Warning, Alert
Architect(s)	2021-today The Frequentis Group 2021-2022 The GOF2 U-Space Project Consortium
Status	Provisional

Table 3: Service Identification

3 Operational Context

This section describes the context of the service from an operational perspective.

3.1 Functional and Non-functional Requirements

The table below lists applicable existing requirements for the **TrafficConformanceMonitoring Exchange** service.

Requirement Id	Requirement Name	Requirement Text	References
[R-1]	Common Situational Awareness	At all times, all U-space participants shall operate on the same common set of data, during pre-flight planning stages as well as during all stages of flight operations.	CORUS [CORUS], 3.1.1.2 Z Volumes; B1-RPAS [ICAO-GANP];CEF-SESAR-2018-1 [GOF1-I-CFP], Objective O5
[R-2]	Basis for Open Market	The U-space concept shall be designed such as to ensure a well-established line of authority while at the same time ensuring that an open market for VLL services may develop	SESAR Drone Roadmap [EATMP-Drone], Foreword, 4.1 and 4.2;U-space Blueprint [UspaceBlueprint], Benefits to European society and economy; CEF-SESAR-2018-1 [GOF1-I-CFP], Table 8 – Key Challenges
[R-3]	Interoperability	There shall be an implementation of a Flight Information Management System (FIMS) which ensures that, at all times, emerging unmanned traffic management systems and existing technologies from manned operations can exchange any data required to support such common situational awareness, be it for drone operations in areas where established ATC procedures apply, or in zones outside established ATC.	ICAO Doc 10039 [ICAO-SWIM];[R-2];CEF-SESAR-2018-1 [GOF1-I-CFP], Objective O6; CEF-SESAR-2018-1 [GOF1-I-CFP], Table 8 – Key Challenges **Note: The term 'Flight Information Management System (FIMS)' in some of these references has been since replaced by 'Common Information Services (CIS)'. This text hence elsewhere refers to CIS, rather than FIMS.**
[R-4]	Standard Protocols	Standard communication protocols shall hence be used where available, and such	[R-2];SESAR Drone Roadmap [EATMP-Drone], 3.5, section 'Standards'; CEF-SESAR-

		standard protocols be developed otherwise, in order to ensure the lowest level of obstruction for an open VLL airspace use market to develop.	2018-1 [GOF1-I-CFP], Table 8 – Key Challenges
[R-5]	Open Interfaces	Any interface and protocol hence must be openly defined and its definition be freely accessible in order to ensure the lowest level of obstruction for an open VLL airspace use market to develop.	[R-2];CEF-SESAR-2018-1 [GOF1-I-CFP], Table 8 – Key Challenges
[R-6]	SWIM	The implementation of a Flight Information Management System (FIMS) shall be based on an ICAO SWIM-compliant architecture.	[R-3];CEF-SESAR-2018-1 [GOF1-I-CFP], 5.3.4 Overall approach and methodology **Note: The term 'Flight Information Management System (FIMS)' used therein has been since replaced by 'Common Information Services (CIS)'. This text hence elsewhere refers to CIS, rather than FIMS.**
[R-7]	Latency	Under no operational circumstance, the processing of position data may add significant latency to the overall detection-to-display latency of position data. In particular, The processing latency added by the processing of positional data shall never exceed 10 per cent of the maximum value of the corresponding value permitted for the entire ATM automation system. The processing latency and delay added by the processing of positional data should not exceed 1 per cent of the maximum value of the corresponding value permitted	[FAA-SUR-PERF], tables in the Executive Summary, [EC-ATM-PERF], 3N_C-R8 and 5N_C-R8

		for the entire ATM automation system. The maximum value for latency and delay is the minimum of the values defined by the ATM system performance requirements by EUROCONTOL and the FAA; for a 3 NM minimal separation, this is 2.2 s, for a 5 NM separation, 2.5 s.	

Table 4: Requirements for the TrafficConformanceMonitoring Service

3.2 Other Constraints

3.2.1 Relevant Industrial Standards

3.2.1.1 ICAO SWIM

The System Wide Information Management (SWIM, [ICAO-SWIM]) complements human-to-human with machine-to-machine communication, and improves data distribution and accessibility in terms of quality of the data exchanged. The SWIM Concept addresses the challenge of creating an "interoperability environment" which allows the SWIM IT systems to cope with the full complexity of operational information exchanges. The SWIM environment shifts the ATM information architecture paradigm from point-to-point data exchanges to system-wide interoperability.

3.2.1.2 EUROCONTROL ASTERIX

The All-purpose structured EUROCONTROL surveillance information exchange (ASTERIX) [EC-ASTERIX] is a set of documents defining the low level ("down to the bit") implementation of a data format used for exchanging surveillance-related information and other ATM applications.

EUROCONTROL-SPEC-0149-9 - EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 9 Category 062 SDPS Track Messages

EUROCONTROL-SPEC-0149-12 - EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 12 Category 21 ADS-B Target Reports

EUROCONTROL-SPEC-0149-14 - EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 14 Category 20 Multilateration Target Reports

EUROCONTROL-SPEC-0149-17 - EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 17 Category 004 Safety Net Messages

EUROCONTROL-SPEC-0149-28 - EUROCONTROL Specification for Surveillance Data Exchange – ASTERIX Part 28 - Category 015: INCS System Target Reports

EUROCONTROL-SPEC-0149-29 - EUROCONTROL Specification for Surveillance Data Exchange – ASTERIX Part 29 - Category 129: UAS Identification Reports

EUROCONTROL-SPEC-0149-30 - EUROCONTROL Specification for Surveillance Data Exchange – ASTERIX Part 30 - Category 016: Independent Non-Cooperative Surveillance System Configuration Reports

EUROCONTROL-SPEC-0149-31 - EUROCONTROL Specification for Surveillance Data Exchange – ASTERIX Part 31 - Category 205: Radio Direction Finder Reports

3.2.1.3 EUROCONTROL ATM Automation System Environment Performance Requirements

EUROCONTROL defines clear operational requirements and an elaborated assessment methodology for European surveillance in its Specification for ATM Surveillance System Performance [EC-ATM-PERF]. For instance, for a separation of 3 nautical miles:

Req. #	Quality of Service	Mandatory Performance
3N_C-R8	Forwarded pressure altitude average data age (see Note 7 in § 3.4.5)	Less than or equal to 2.5 seconds

Table 5: **Excerpt from EUROCONTROL Specification for ATM Surveillance System Performance [EC-ATM-PERF]**

INFO More requirements for update rates and error margins apply.

3.2.1.4 FAA ATM Automation System Environment Performance Requirements

In a similar fashion, the Federal Aviation Administration concludes that the time from the determination of a position (measurement) to display (latency of the ATM system) shall not exceed similar values [FAA-SUR-PERF]:

Latency	**2.2 seconds to display maximum**

The FAA also applies further requirements for update rates and error margins.

3.2.1.5 EUROCONTROL Safety Nets, A Guide for Ensuring Effectiveness

TrafficConformanceMonitoring with safety nets constitutes the ultimate safety layer with very short timescales remaining to prevent the occurrence of a serious situation [EC-SN-Guide]:

"Safety nets are either ground-based or airborne:

Ground-based safety nets are an integral part of the ATM system. Primarily using ATS surveillance data, they provide warning times of up to two minutes. Upon receiving an alert, air traffic controllers are expected to immediately assess the situation and take appropriate action.

Airborne safety nets provide alerts and resolution advisories directly to the pilots. Warning times are generally shorter, up to about 40 seconds. Pilots are expected to immediately take appropriate avoiding action. ..."

3.2.2 Operational Nodes

A typical U-space flight goes through several stages, starting strategic-tactically, pre-flight, from Strategic Planning, over to Pre-Tactical Planning, to Tactical Planning. Then, tactical-operationally it

enters into the actual in-flight stages from Departure, over to In-Flight, and, finally Arrival. Further post-flight stages may evaluate the results from the data produced during the prior stages.

The **TrafficConformanceMonitoring** service primarily is relevant during the actual operational in-flight stages of a U-space flight during which the flying device and/or the corresponding ground stations produce the position data which we convey via the Traffic/Telemetry exchange service.

The operational **TrafficConformanceMonitoring** service consumes position information provided by the authoritative Tracking service of the area of its responsibility.

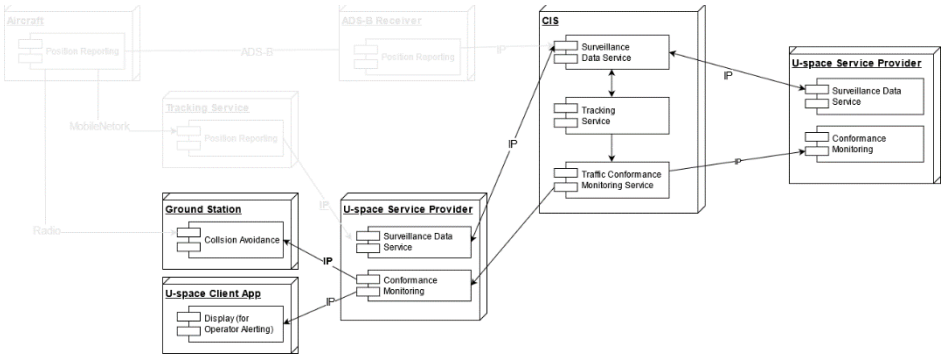

Figure 2: U-space Nodes Related to the TrafficConformanceMonitoring Service

Typically, consuming services and applications will utilize the service together with other services like:

- Tracking Services - for reliable, timely traffic information in the area of interest for a reliable situational awareness
- Registration Services - for background on e.g. operator, pilot and flown device
- Geofencing Services – to draw a user's attention to a potential area conflict and to act accordingly, possibly even automatically

Consuming services and applications include the following services and applications:

- Tactical Deconfliction Service
- Traffic Alerting Service, including
  - at an operator's U-space client U-space display for operator alerting, or
  - at an operators ground station, triggering tactical collision avoidance
- Displays for Situational Overview
- Accident and Incident Reporting Services
- Legal Recording Service

Operational nodes which can provide data for the Traffic Conformance Monitoring service include the following ones:

Operational Node	Remarks

Tracking Server	Single Source of Truth for the area of responsibility of the Tracking and the **TrafficConformanceMonitoring** services

Table 6: Operational Nodes Providing to the TrafficConformanceMonitoring Service

Operational nodes which may consume the Traffic Conformance Monitoring service include the following ones.

Operational Node	Remarks
Common Information Service	
Information Display	
Telemetry Converter	
Legal Recorder	

Table 7: Operational Nodes Consuming the TrafficConformanceMonitoring Service

3.2.3 Operational Activities

Operational activities supported by the Traffic Conformance Monitoring service include the following ones.

Phase	Operational Activity	Remarks
Pre-flight	**Set-up**	**(Telemetry input likely not operational yet at this stage)**
	Plan	**(Telemetry input likely not operational yet at this stage)**
	Arm	**(Traffic/telemetry input should start to run here)**
In-Flight	Depart	With the availability of Tracking information of the flight, Traffic Conformance Monitoring starts now
	Cruise	Traffic Conformance Monitoring operational for the flight
	Arrive	Traffic Conformance Monitoring operational for the flight
Post-Flight	Disarm	**(Traffic/telemetry likely stops here, so the Traffic Conformance Monitoring for the flight ceases now)**
	Report	**(Post/flight analysis only)**

Table 8: Operational Activities Supported by the TrafficConformanceMonitoring Service

3.3 Service Interfaces

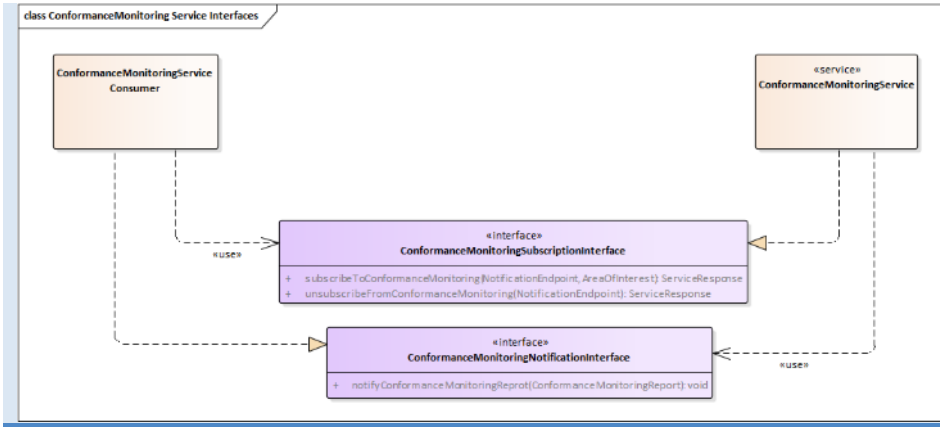

Figure 3: TrafficConformanceMonitoring Exchange Interface Definition Diagram

Service Interface	Role (from service provider point of view)	Service Operation
TrafficConformanceMonitoringSubscriptionInterface	Provided	**subscribeToTrafficConformanceMonitoring** **unSubscribeFromTrafficConformanceMonitoring**
TrafficConformanceMonitoringNotificationInterface	Required	**notifyTrafficConformanceMonitoringReport**

Table 9: Service Interfaces

4 Service Data Model

This section describes the information model, i.e., the logical data structures that are exchanged between providers and consumers of the service.

4.1 Overview

The Traffic Conformance Monitoring exchange service provides its consumers with TrafficConformanceMonitoringReports. A TrafficConformanceMonitoringReport is one of

- TrafficNonConformanceMonitoringReport, or
- TrafficConformanceMonitoringStatusReport.

A TrafficNonConformanceMonitoringReport informs about a conflict situation reports of conflict situations of one or more **TrafficConformanceMonitoringObject**s. It gives information about the involved objects, characteristics of the conflict, and time and spatial separation.

It is mandatory to provide at least one TrafficConformanceMonitoringObject as the originatingObject data item in each **TrafficNonConformanceMonitoringReport.**Additional TrafficConformanceMonitoringObjects may be added as relatedObjects, if available.

Each **TrafficConformanceMonitoringObject** must include at least one **ObjectIdentifiation** data item which refers to a TRACK. Data sources should report all further **ObjectIdentification** data items they have information about. In fact, this specification relies on it as means to convey essential information.

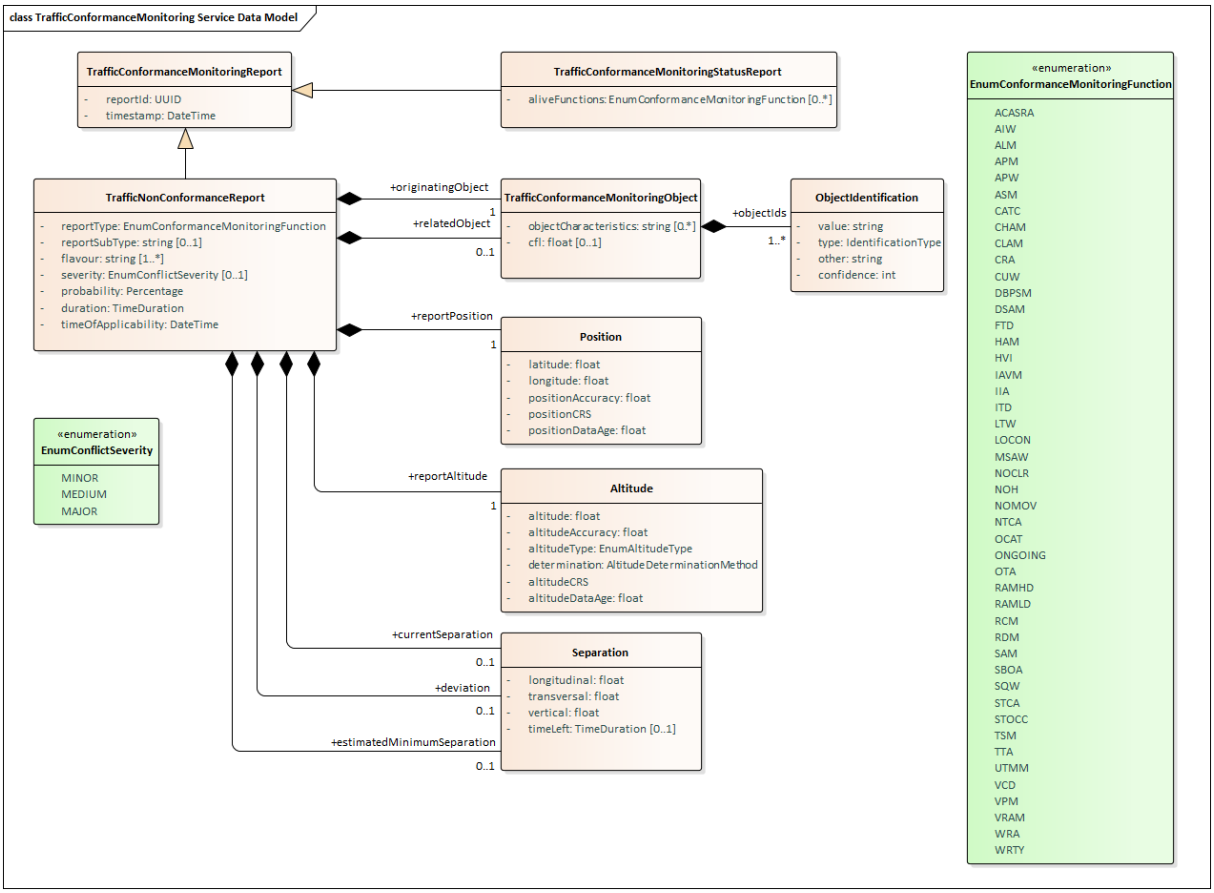

Figure 4: TrafficConformanceMonitoringReport Data Model Diagram of the Traffic Conformance Monitoring Exchange Service

4.1 TrafficConformanceMonitoringReport Data Structure

The **TrafficConformanceMonitoringReport** data structure is the base report structure being distributed to subscribed service consumers.
Its properties are inherited by both specific report structures TrafficNonConformanceReport and TrafficConformanceMonitoringStatusReport.

Property	Type	Multiplicity	Description	Note
reportId	UUID	1	Globally unique identifier of the report.	
timestamp	DateTime	1	Timestamp of when the report was sent.	

Tab.: TrafficConformanceMonitoringReport Data Structure

4.2 TrafficNonConformanceReport Data Structure

The **TrafficNonConformanceReport** data structure carries the data describing a traffic non-conformance situation.

Property	Type	Multiplicity	Description	Note
originatingObject	TrafficConformanceMonitoringObject	1	The TrafficConformanceMonitoringObject structure holds the object originating the Traffic Conformance Monitoring report.	
relatedObject	TrafficConformanceMonitoringObject	0..*	The TrafficConformanceMonitoringObject structure holds an object involved in the Traffic Conformance Monitoring report.	This can be another aircraft but also an area, or other.
reportPosition	Position	1	The Position structure holds the anticipated or actual position of the issue conveyed with this Traffic Conformance Monitoring report.	
reportAltitude	Altitude	1	The corresponding Altitude structure holds the altitude of the issue conveyed with this Traffic Conformance Monitoring report.	
currentSeparation	Separation	1	The Separation structure holds the current separation from the conflict, plus the estimated time left until the conflict.	
estimatedMinimumSeparation	Separation	1	The Separation structure holds the estimated minimum separation, plus the estimated time left until	

			the minimum separation occurs.	
deviation	Separation	1	The Separation structure holds the current deviation from the agreed operation plan.	
reportType	EnumConformanceMonitoringFunction	1	The type of non-conformance carried inthe report.	
reportSubType	String	0..1	If required, the subtype of the report may be set as follows. For reportType = RIMCAS alerts, one of: RRC Runway/Runway crossing RTC Runway/Taxiway crossing RAS1 Alert stage one RAS2 Alert stage two For reportType = UTMM, one of: WrongDirection Object travelling in direction it is not cleared to travel WrongTaxiway Object on wrong taxiway Speeding Object travelling faster than permitted For reportType = MSAW: MRVA Minimum radar vector altitude alert For reportType = VRAM, one of: CRM Cleared rate monitor alert VRM Vertical rate monitor alert VTM Vertical tracker	

			monitor alert FastClimb Object climbing fast SlowClimb Object climbing slowly FastDescent Object descending fast SlowDescent Object descending slowly For reportType = HAM, one of: HD Heading deviation alert RD Rate deviation alert VD Vertical deviation alert FastClimb Object climbing fast SlowClimb Object climbing slowly FastDescent Object descending fast SlowDescent Object descending slowly Above Object above cleared level Below Object below cleared level For reportType = DBPSM, one of: ARR Alert upon arrival DEP Alert upon departure TL Alert above transition level For reportType = AIW: pAIW AIW relies on primary surveillance only For reportType = STCA, one of: LPF Linear Prediction Filter set CPF Current Proximity Filter set

			MHF Maneouvere Hazard Filter set For reportType = DSAM, one of: EarlyVManeouvre Vertical maneouvre of object comes early LateVManeouvre Vertical maneouvre of object comes late For reportType = FTD, ITD and IIA, one of: (Real number) Separation value in m MRS1 Minimum radar separation on arrival (single RWY) ROT1 Separation based on runway separation occupancy time (single RWY) GAP1 Separation based on manually entered ATCO gap (single RWY) MRS2 Minimum radar separation on arrival (parallel RWY) ROT2 Separation based on runway separation occupancy time (parallel RWY) GAP2 Separation based on manually entered ATCO gap (parallel RWY) For reportType = CATC, one of: LineUpVsLineUp Line-Up vs. Line-Up LineUpVsCrossEnter Line-Up vs. Cross or Enter LineUpVsTakeoff Line-Up vs. Takeoff LineUpVsLanding Line-Up vs. Landing CrossEnterVsLineUp Cross or Enter vs. Line-Up

			CrossEnterVsCrossEnter Cross or Enter vs. Cross or Enter CrossEnterVsTakeoff Cross or Enter vs. Takeoff CrossEnterVsLanding Cross or Enter vs. Landing TakeoffVsLineUp Take-Off vs. Line-Up TakeoffVsCrossEnter Take-Off vs. Cross or Enter TakeoffVsTakeoff Take-Off vs. Takeoff TakeoffVsLanding Take-Off vs. Landing LandingVsLineUp Landing vs. Line-Up LandingVsCrossEnter Landing vs. Cross or Enter LandingVsTakeoff Landing vs. Takeoff LandingVsLanding Landing vs. Landing PushBackVsPushBack Push-back vs. Push-back PushBackVsTaxi Push-back vs. Taxi TaxiVsPushBack Taxi vs. Push-back TaxiVsTaxi Taxi vs. Taxi For reportType = NOCLR, one of: NoPushBackClearance Object moving without clearance to push back NoTaxiClearance Object on taxiway without clearance NoLineUpClearance Object lining up without clearance NoCrossingClearance Object crossing runway without clearance NoEnterClearance Object entering runway without

			clearance NoTakeoffClearance Object taking off without clearance NoLandingClearance Object Landing without clearance For reportType = NOMOV, one of: AfterPushBackClearance Object stationary despite push-back clearance AfterTaxiClearance Object stationary despite taxi clearance AfterLineUpClearance Object lining up too late AfterCrossingClearance Object crossing runway too clearance AfterEnterClearance Object entering runway too late AfterTakeoffClearance Object too late for take-off StationaryOnRWY Object stationary on runway StationaryOnTWY Object stationary on taxiway For reportType = NOH, one of: NoContact No contact made, as seen from the receiving ATSU side NoTransfer No transfer made, as seen from the leaving ATSU side	
flavour	String	1..*	The flavour of the report, one or more of: Military Conflict location in military airspace Civil Conflict location in civil airspace StateReserved Conf	

			lict location in reserved airspace FastLateralDivergence Objects are fast diverging laterally at current time FastVerticalDivergence Objects are fast diverging vertically at current time Crossed Objects have crossed at starting time of conflict Diverging Objects diverging at starting time of conflict Opposing Objects in opposing direction	
severity	EnumConflictSeverity	0..1	The severity assigned to the reported conflict.	
probability	Percentage	1	The probability of the reported situation to occur. Range: 0...100	
duration	TimeDuration	1	The duration, in seconds, since the report is being raised.	
timeOfApplicability	DateTime	1	The time of applicability of this report	
…			All properties inherited from TrafficConformanceMonitoringReport.	

Table 10: TrafficNonConformanceReport Data Structure

4.3 TrafficConformanceMonitoringStatus Data Structure

The TrafficConformanceMonitoringStatusReport data structure carries the data describing the current status of the TrafficConformanceMonitoring service provider.

It is expected that such TrafficConformanceMonitoringStatusReports are published periodically over the same channel as non-conformance reports are published, so subscribed consumers get informed about active service provision.

Property	Type	Multiplicity	Description	Note

aliveFunctions	EnumConformanceMonitoringFunction	0..1	The list of currently provided monitoring functions.	
...			All properties inherited from TrafficConformanceMonitoringReport.	

Tab.: TrafficConformanceMonitoringStatusReport Data Structure

4.4 EnumConformanceMonitoringFunction Enumeration

The EnumConformanceMonitoringFunction enumeration type specifies the available monitoring functions .

Property	Description	Note
ACASRA	ACAS Resolution Advisory	
AIW	Airspace Infringement Warning	
ALM	RIMCAS – Arrival / Landing Monitor	
APM	Approach Path Monitor	
APW	Area Proximity Warning	
ASM	RIMCAS – Arrival/Departure Aircraft Separation Monitor	
CATC	Conflicting ATC Clearances	
CHAM	Cleared Heading Adherence Monitor	
CLAM	Clearance Level Adherence Monitor	
CRA	RIMCAS – Arrival/Departure Close Runway Alert	
CUW	Catch-Up Warning	
DBPSM	Downlinked Barometric Pressure Setting Monitor	
DSAM	Downlinked Selected Altitude Monitor	
FTD	Final Target Distance Indicator	
HAM	Holding Adherence Monitor	
HVI	Holding Volume Infringement	
IAVM	RIMCAS – ILS Area Violation Monitor	
IIA	Wake Vortex Indicator Infringement Alert	

ITD	Initial Target Distance Indicator	
LTW	Lost Track Warning	
LOCON	Loss of Control warning	
MSAW	Minimum Safe Altitude Warning	
NOCLR	No ATC Clearance	
NOH	Aircraft Leaving/Entering Aerodrome Area without Handover	
NOMOV	Aircraft not moving despite ATC Clearance	
NTCA	Near Term Conflict Alert	
OCAT	Outside Controlled Airspace Tool	
ONGOING	Ongoing Alert	
OTA	RIMCAS – Arrival / Departure Opposite Traffic Alert	
RAMHD	Route Adherence Monitor Heading Deviation	
RAMLD	Route Adherence Monitor Longitudinal Deviation	
RCM	RIMCAS – Runway / Taxiway Crossing Monitor	
RDM	RIMCAS – Departure Monitor	
SAM	Speed Adherence Monitor	
SBOA	RIMCAS – Stop Bar Overrun Alert	
SQW	Sequence Warning on Final Approach	
STCA	Short Term Conflict Alert	
STOCC	Stand Occupied	
TSM	RIMCAS – Taxiway Separation Monitor	
TTA	RIMCAS – Taxiway Traffic Alert	
UTMM	RIMCAS – Unauthorized Taxiway Movement Monitor	
VCD	Vertical Conflict Detection	
VPM	Vertical Path Monitor	
VRAM	Vertical Rate Adherence Monitor	
WRA	RIMCAS – Arrival / Departure Wrong Runway Alert	

WRTY	Wrong Runway or Taxiway Type	

Tab.: EnumConformanceMonitoringFunction Enumeration

4.5 EnumConflictSeverity Enumeration

The EnumConflictSeverity enumeration type specifies levels of severity of a non-conformance.

Property	Description	Note
MINOR	minor severity	
MEDIUM	medium severity	
MAJOR	major severity	

Tab.: EnumConflictSeverity Enumeration

4.6 TrafficConformanceMonitoringObject Data Structure

The **TrafficConformanceMonitoringObject** data structure defines the structure which may carry the required information about an object involved with this Traffic Conformance Monitoring report.

Property	Type	Multiplicity	Description	Note
objectCharacteristics	**String Array**	0..*	Additional classification flags regarding this **TrafficConformanceMonitoringObject**, one or more of: GAT Indicates General Air Traffic OAT Indicates Operational Air Traffic IFR Indicates Instrumental Flight Rules VFR Indicates Visual Flight Rules CVFR Indicates Controlled Visual Flight Rules RVSM-OK Indicates approved RVSM operation RVSM-NO Indicates exemption from RVSM RVSM-EX Indicates NOT approved RVSM HPR Indicates High	The **objectCharacteristics** can be empty under some circumstances, or hold multiple entries. This item is there primarily to ensure immediate forwarding of resolution advisories without delay of at least a minimum of information without delay. Data originators shall make use of the

			Priority operation CDM-UP Indicates climbing operation CDM-DOWN Indicates descending operation CDM-LEVEL Indicates operation maintaining flight level GV Indicates a ground vehicle	**ObjectIdentification** structure to the most complete extent as possible but also should fill this item as appropriate.
cfl	**Real**	0..1	Cleared flight level	

Table 11: TrafficConformanceMonitoringObject Data Structure

There shall be at least one **TrafficConformanceMonitoringObject** type **originatingObject** data structure provided for every **TrafficNonConformanceReport** which holds the information of the object originating the Traffic Conformance Monitoring report. The Position shall be set to the position of the expected report situation. In most cases, there will be a **TrafficConformanceMonitoringObject** type **relatedObject** data structure containing the corresponding information of the related object which may be, for instance, another aircraft, a restricted area, or a gate.

4.7 ObjectIdentification Data Structure

The **ObjectIdentification** data structure can carry data to assist in identifying the object we report about in this report. It can be a vehicle registration identifier, or any other identifier as listed in the **IdentificationType** property.

Property	Type	Multiplicity	Description	Note
object_identification_value	**String**	1	The actual value of the identification of the object this report applies to, of type **object_identification_type.**	
object_identification_type	**IdentificationType**	1	Type of identification conveyed by this **ObjectIdentification** item, one of: ICAO indicating an ICAO 24 bit address CALLSIGN indicating an (ITU) call sign as designated by the country of registration	

			ETHER indicating an Ethernet address Primary (primary surveillance) Mode3A (secondary surveillance, 2D only, squawk) Mode3AC (secondary surveillance, 3D, squawk) ModeS (secondary surveillance, ICAO 24 bit address) Combined (combined primary/secondary surveillance) ModeSES (dependent surveillance, ICAO 24 bit address) VDL (dependent surveillance, ICAO 24 bit address) UAT (dependent surveillance, ICAO 24 bit address) MLAT (secondary surveillance, ICAO 24 bit address) TRACK (combined surveillance, numeric track id) TRACKID (combined surveillance, track uuid) ALERT (surveillance, numeric alert id) ALERTID (surveillance, alert uuid)	

			ADSC (dependent surveillance, ICAO 24 bit address) FPL (dependent surveillance, squawk or no id) GUFI (operation-id, i. e. the uuid of the operation) FLARM (dependent surveillance, FLARM-ID) IMEI (dependent surveillance, IMEI number) IMSI (dependent surveillance, IMSI number) MMSI (dependent surveillance, MMSI number) SERIAL (dependent surveillance, serial number of the vehicle as assigned by its manufacturer) MAKER (dependent surveillance, three letters identifying the manufacturer of the vehicle) MODEL (dependent surveillance, three letters identifying the model of the manufacturer of the vehicle) COUNTRY (dependent surveillance, ISO 3166-1 Alpha 2 code of the country of registration of the vehicle)

			AREA (name of an area) AREAID (uuid of an area) CROSS_AREA (name of a crossing area) CROSS_AREAID (uuid of a crossing area) GATE (designator of a gate) GATEID (uuid of a gate) RWY (designator of a runway) RWYID (uuid of a runway) TWY (designator of a taxiway) TWYID (uuid of a taxiway) SECTOR (designator of a control sector) SECTORID (uuid of a control sector) STBAR (designator of a stop bar) STBARID (uuid of a stop bar) OTHER **discouraged**, referring to **object_identification_other** below
object_identification_other	**String**	0..1	Optional empty item for temporary use until standardization is in place: Unless **object_identification_typ**

			e is set to "OTHER", do not set this field at all; however, if **object_identification_type** is set to "OTHER", set this field to a descriptive string for the type and set **object_identification_value** to the corresponding value. **INFO** Use of this field is **discouraged** at any time and permitted for local bilateral temporary deviation of standard only until updated standardization is in place.	
object_identification_confidence	**Integer**	0..1	Optional item with a range from 0 to 100 representing the degree of confidence the emitter of this information has that the object we report about in this report actually can be identified by this particular **object_identification_value**.	

Table 12: ObjectIdentification Data Structure

Data sources should report all **ObjectIdentification** data items they have data about.

There shall be at least one **ObjectIdentification** data structure present, carrying a data item of **object_identification_type=TRACK**. Data sources should provide as many **ObjectIdentification** data structures as they have data available for a given **TrafficConformanceMonitoringObject**.

4.8 The Position Data Structure

The **Position** data structure carries the position data of the object being reported about.

Property	Type	Multiplicity	Description	Note
latitude	Real	1	Latitude of position record in unit of measurement as	

			defined by positionCrs	
longitude	Real	1	Longitude of position record in unit of measurement as defined by positionCrs	
positionAccuracy	Real	1	Accuracy of latitude and longitude in unit of measurement as defined by positionCrs	
positionCrs	Reference	1	Coordinate reference system used (e. g., for WGS-84, EPSG:4979)	
positionDataAge	Real	0..1	Elapsed time in s since last position data received by the reporter of this **Position**	This attribute shall be provided, if the Position is used in a reporting service (e.g., in a PositionReport); in other cases this attribute may be omitted (e.g., in conversion operations).

Table 13: The Position **data structure**

There shall be exactly one **reportPosition** for each **TrafficNonConformanceReport**.

4.9 The Altitude Data Structure

The Altitude data structure carries the altitude data of the object being reported about.

Property	Type	Multiplicity	Description	Note
altitude	Real	1	Altitude of position record in m unit of measurement as defined	

			by altitudeCrs.	
altitudeAccuracy	Real	1	Accuracy of altitude in in unit of measurement as defined by altitudeCrs	
altitudeType	EnumAltitudeType	1	indicates the reference point for altitude measurement, e. g.: altitude above mean-sea-level (MSL) altitude above take-off location (ATO) altitude above ground (AGL/SFC)	
determinationMethod	AltitudeDeterminationMethod	1	Method of determination of altitude, e. g.: radio-altimeter barometric GNSS-based calculated against reference point and	

			mean-sea-level	
altitudeCrs	EnumCRSType	1	Coordinate reference system used (e. g., for WGS-84, EPSG:4979)	
altitudeDataAge	Real	0..1	Elapsed time in s since last position data received by the reporter of this **Altitude**	This attribute shall be provided, if the Altitude is used in a reporting service (e.g., in a PositionReport); in other cases this attribute may be omitted (e.g., in conversion operations).

Table 14: The Altitude **data structure**

4.10 The EnumAltitudeType Enumeration

The EnumAltitudeType enumeration type specifies the possible ways to express an altitude/height.

See Common Geometry Data types.

4.11 The EnumCRSType Enumeration

The EnumCRSType enumeration type specifies the possible ways to express a coordinate reference system.

See Common Geometry Data types.

4.12 The AltitudeDeterminationMethod Enumeration

The AltitudeDeterminationMethod enumeration type specifies the possible ways to determine an altitude.

Property	Description	Note

RADIO_ALTIMETER	Altitude measured via radio altimeter.	
BAROMETRIC	Altitude measured via air pressure.	
GNSS_BASED	Altitude obtained by satellite navigation system.	
CALCULATED	Altitude calculated against reference point.	

Table 15: The AltitudeDeterminationMethod enumeration

There shall be exactly one **reportAltitude** for each **TrafficNonConformanceReport**.

4.13 Separation Data Structure

The **Separation** data structure provides a means to carry spatial separation information of the objects considered.

Property	Type	Multiplicity	Description	Note
longitudinal	**Real**	1	The separation, in metres, in the direction of movement, of this object to the other object involved.	A deviation 'ahead' of the planned position should be annotated as a positive figure, or as a negative figure if 'behind' the planned position.
transversal	**Real**	1	The separation, in metres, transversal to the direction of movement, of this object to the other object involved.	A deviation 'to the right' (in the sense of movement) of the planned position should be annotated as a positive figure, or as a negative figure if 'to the left'.
vertical	**Real**	1	The vertical separation, in metres, in the direction of movement, of this object to the other object involved	A deviation 'above' of the planned position should be annotated as a positive figure, or as a negative figure if 'below'.
timeLeft	**TimeDuration**	0..1	The time left, in s, until the reported conflict occurs, or is expected to occur.	A deviation has no **timeLeft**.

Table 16: Separation Data Structure

4.14 Common Data Structures Used in UTM Service Specifications

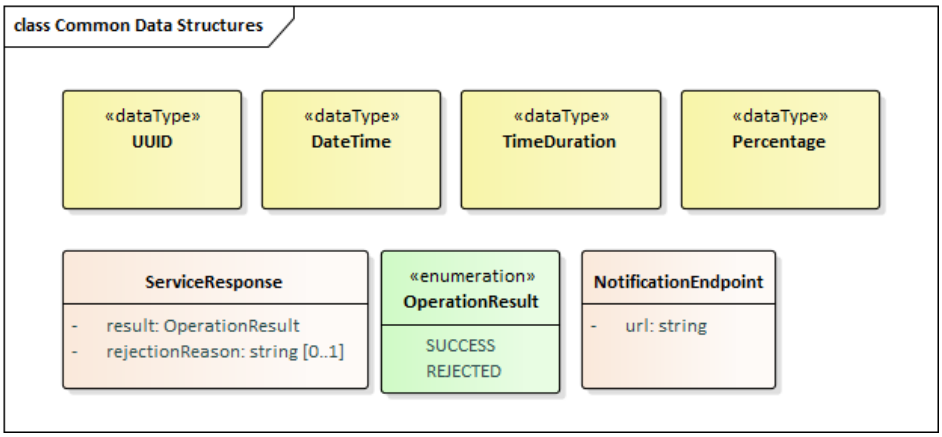

Figure 5: Common Data Types Used in UTM Service Specifications

4.14.1 NotificationEndpoint Data Structure

NotificationEndpoint is used in subscription and un-subscription operations to show the receiver of notifications as a result of the subscription.

Property	Type	Multiplicity	Description	Note
URL	**String**	1	Endpoint capable of receiving notifications	

Table 17: NotificationEndpoint Data Structure

4.14.2 ServiceResponse Data Structure

ServiceResponse is the generic response provided by each service operation. In some cases, this basic data structure may be extended by inheritance.

Property	Type	Multiplicity	Description	Note
result	**OperationResult**	1	Indicates the result of the request to the service	
rejectReason	**String**	0..1	Optional additional information to be provided in case of negative result	

Table 18: ServiceResponse Data Structure

4.15 Common Geometry Data Structures Used in UTM Service Specifications

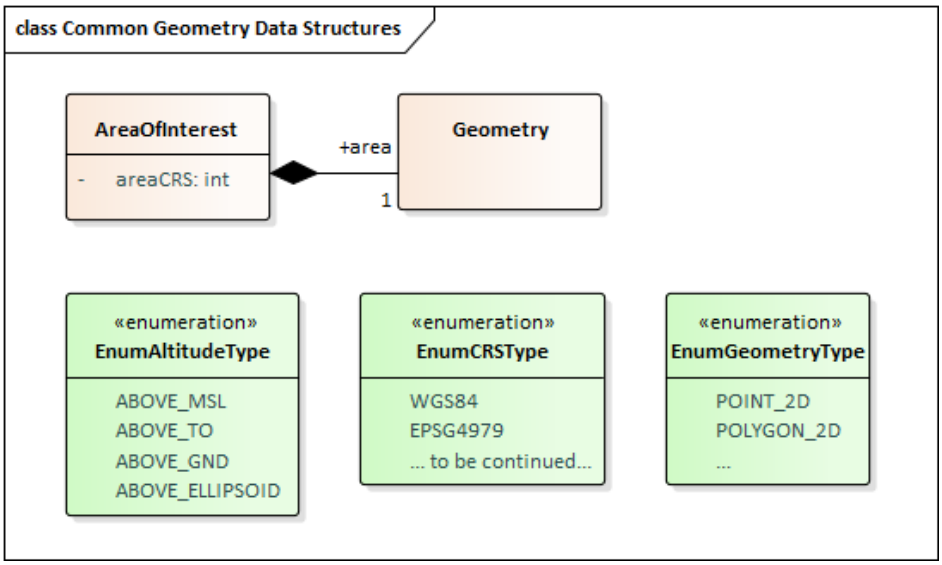

Figure 6: Common Geometry Data Types Used in UTM Service Specifications

4.15.1 AreaOfInterest Data Structure

AreaOfInterest is used in subscription operations to provide an indication of the geographic area for which the subscriber is interested to receive notifications.

Property	Type	Multiplicity	Description	Note
area	**Geometry**	1	A geometric description of a geographic area.	Should be a 2-dimensional geometry in this case.
areaCRS	**EnumCRSType**	1	Coordinate reference system used (WGS-84, EPSG:4979)	

Table 19: AreaOfInterest Data Structure

4.15.2 Geometry Data Structure

Geometry describes a geometrical shape of one, two or three dimensions.

The **Geometry** data structure is not further detailed in this service specification. One example of how a generic Geometry structure could be realized is sketched in the table below:

Property	Type	Multiplicity	Description	Note

coordinates	**Double**	2..*	Collection of the coordinates, describing the geometry.	
geometryType	**GeometryType**	1	Type of geometry being described by the coordinates.	Examples: Point, Polygon, Polyhedron, etc.

Table 20: Geometry Data Structure

4.15.3 EnumAltitudeType Enumeration

The EnumAltitudeType enumeration type specifies the possible ways to express an altitude/height.

Property	Description	Note
ABOVE_MSL	Altitude above mean-sea-level. Same as orthometric height; same as height above the earth geoid.	
ABOVE_TO	Altitude above take-off location.	
ABOVE_GND	Height above ground surface.	
ABOVE_ELLIPSOID	Altitude above the WGS-84 ellipsoid; value delivered by GPS.	

Table 21: EnumAltitudeType Enumeration

4.15.4 EnumCRSType Enumeration

The **EnumCRSType** enumeration type specifies the possible ways to express a coordinate reference system.

Property	Description	Note
WGS84		
EPSG4979		
... to be continued ...		

Table 22: EnumCRSType Enumeration

4.15.5 EnumGeometryType Enumeration

The **EnumGeometryType** enumeration type specifies possible geometrical shapes.

Property	Description	Note
POINT	Single point.	
POLYGON	Polygon.	

…		

Table 23: EnumGeometryType Enumeration

5 Service Interface Specifications

This chapter describes the details of each service interface. Each Service Interface has its own sub-chapter.

The Service Interface specification covers only the static design description while the dynamic design (behaviour) is described later.

5.1 Service Interface TrafficConformanceMonitoringSubscriptionInterface

5.1.1 Operation subscribeForTrafficConformanceMonitoring

5.1.1.1 Operation Functionality

A consumer calls this operation to subscribe to Traffic Conformance Monitoring report data.

5.1.1.2 Operation Parameters

Parameter Name	Direction	Data Type	Description
consumer	Input	**NotificationEndpoint**	Which endpoint shall be notified in case of new **ConformanceReports**
areaOfInterest	Input	**AreaOfInterest**	Area of interest to the consumer
response	Return	**ServiceResponse**	Provide status information on subscription

Table 24: Payload Description of subscribeForTrafficConformanceMonitoring Operation

5.1.2 Operation unSubscribeForTrafficConformanceMonitoring

5.1.2.1 Operation Functionality

A consumer calls this operation at the provider to unsubscribe from Traffic Conformance Monitoring report data.

5.1.2.2 Operation Parameters

Parameter Name	Direction	Data Type	Description
consumer	Input	**NotificationEndpoint**	Which endpoint shall be not be notified (anymore) in case of new **TrafficConformanceMonitoringReports**
response	Return	**ServiceResponse**	Provide status information on subscription

Table 25: Payload Description of unSubscribeForTrafficConformanceMonitoring Operation

5.2 Service Interface TrafficConformanceMonitoringNotificationInterface

Consumer provides this interface, allowing the service provider to submit to the consumer Traffic Conformance Monitoring report data.

5.2.1 Operation notifyTrafficConformanceMonitoringReport

5.2.1.1 Operation Functionality

Once and while subscribed, consumer receives Traffic Conformance Monitoring report data via this operation.

5.2.1.2 Operation Parameters

Parameter Name	Direction	Data Type	Description
TrafficConformanceMonitoringReport	Input	**TrafficConformanceMonitoringReport**	A Traffic Conformance Monitoring report that matches the area criterium provided with subscription

Table 26: Payload Description of notifyTrafficConformanceMonitoringReport Operation

6 Service Dynamic Behaviour

6.1 Service Interfaces TrafficConformanceMonitoringSubscriptionInterface and TrafficConformanceMonitoringNotificationInterface

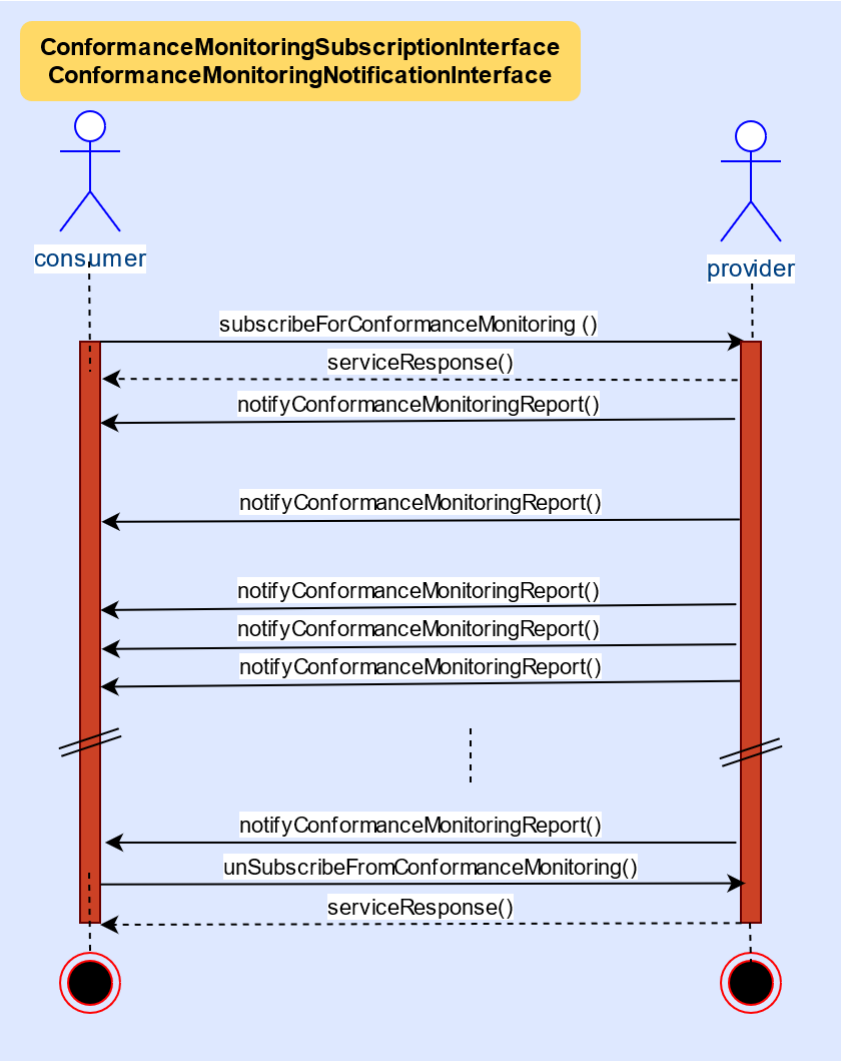

Figure 7: Traffic Conformance Monitoring Exchange Service Interface Operation Sequence Diagram

7 Service Provisioning

Not available, left empty.

8 References

Nr.	Version	Reference
[CORUS]	Ed. 01.01.03 Ed. 03.00.02	CORUS Vol. 1, Enhanced Overview https://www.sesarju.eu/sites/default/files/documents/u-space/CORUS%20ConOps%20vol1.pdf CORUS Vol. 2, U-space Concept of Operations https://www.sesarju.eu/sites/default/files/documents/u-space/CORUS%20ConOps%20vol2.pdf
[EASA-Commission-Draft]	n/a	Annex to EASA Opinion No 01/2020; COMMISSION IMPLEMENTING REGULATION (EU) .../...of XXXon a high-level regulatory framework for the U-space https://www.easa.europa.eu/sites/default/files/dfu/Draft%20COMMISSION%20IMPLEMENTING%20REGULATION%20on%20a%20high-level%20regulatory%20fram....pdf
[EASA-Incident-Manual]	08.03.2021	EASA Manual on Drone Incident Management at Aerodromes PART 1: The challenge of unauthorised drones in the surroundings of aerodromes PART 2: Guidance and recommendations PART 3: Resources and practical tools https://www.easa.europa.eu/newsroom-and-events/press-releases/easa-issues-guidelines-management-drone-incidents-airports
[EATMP]	2020	SESAR, eATM PORTAL, European ATM Master Plan, https://www.atmmasterplan.eu/
[EATMP-Drone]	n/a	SESAR, European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace
[EC-ATM-PERF]	Ed. 1.2	EUROCONTROL Specification for ATM Surveillance System Performance (ESASSP), EUROCONTROL-GUID-0147, https://www.eurocontrol.int/publication/eurocontrol-specification-atm-surveillance-system-performance-esassp
[EC-ASTERIX]	n/a	ASTERIX Library: ASTERIX, All-purpose structured EUROCONTROL surveillance information exchange, Defining the low level implementation of a data format used for exchanging surveillance-related information in ATM applications. Available at https://www.eurocontrol.int/asterix.
[EC-MONA]	Ed. 2.0,	EUROCONTROL Specification for Monitoring Aids, EUROCONTROL-SPEC-0142,

	03/03/2017	https://www.eurocontrol.int/sites/default/files/publication/files/EUROCONTROL-SPEC-0142%20MONA%20Ed%202.0.pdf
[EC-SN-Guide]	August 2017	Safety Nets, A guide for ensuring effectiveness, https://www.eurocontrol.int/sites/default/files/publication/files/safety-nets-guide-august-2017.pdf
[EfficienSea2]	n/a	Efficient, safe and sustainable traffic at sea (EfficienSea2), a Horizon 2020 Project, Grant Agreement No 636329 https://efficiensea2.org https://efficiensea2.org/wp-content/uploads/2018/04/Deliverable-3.6.Standard-proposal-for-Maritime-Cloud-service-specification.pdf
[FAA-SUR-PERF]	1 November 2006	Massachusetts Institute of Technology Lincoln Laboratory for the Federal Aviation Administration, Project Report ATC-323, Required Surveillance Performance Accuracy to Support 3-Mile and 5-Mile Separation in the National Airspace System, https://www.ll.mit.edu/sites/default/files/publication/doc/2018-12/Thompson_2006_ATC-323_WW-15318.pdf
[FAA-UAS-CONOPS]	V1.0	Federal Aviation Administration NextGEN Concept of Operations, Foundational Principles, Roles and Responsibilities, Use Cases and Operational Threads, Unmanned Aircraft System (UAS), Traffic Management (UTM)
[FALKE-ARCH]	V1.0	FALKE System Architecture
[FALKE-GVB]	21.08.2019	Gesamtvorhabensbeschreibung zum Verbundprojekt "Fähigkeit des Abfangens von in gesperrte Lufträume eindringenden Kleinfluggeräten durch zivile Einsatzmittel" (FALKE), Az: DG20-837.4/4-1
[FOCA-USPACE-CONOPS]	1.0	Federal Office of Civil Aviation (FOCA), Swiss U-Space ConOps, U-Space Program Management, 31.10.2018, FOCA muo / 042.2-00002/00001/00005/00021/00003
[GOF1-Arch-AppA]	00.05.00	SESAR 2020 GOF USPACE FIMS Design and Architecture, Appendix A Service Description Templates, document SESAR 2020 GOF USPACE Service Documentation Guidelines
[GOF1-I-CFP]	n/a	CFP Reference CEF-SESAR-2018-1, "Finnish-Estonian "Gulf of Finland" Very Large U-Space Demonstration"
[GUTMA-FLP]	n/a	Global UTM Association (GUTMA) Flight Logging Protocol, https://github.com/gutma-org/flight-logging-protocol/blob/master/Flight_logging_protocol.md
[GUTMA-ATP]	n/a	Global UTM Association (GUTMA) Air Traffic Protocol, https://github.com/hrishiballal/airtraffic-data-protocol-development

[IALA-ENAV]	Ed. 1.1	IALA specification for e-navigation technical services https://www.iala-aism.org/product/g1128-specification-e-navigation-technical-services
[IATA-SR2014]	51st Edition	IATA Safety Report 2014 (Issued April 2015) http://www.aviation-accidents.net/report-download.php?id=90003
[ICAO-GANP]	5th Ed. - 2016	ICAO Doc. 9750-AN/963, Global Air Navigation Plan (GANP) 2016-2030
[ICAO-SWIM]	Advanced Edition (unedited)	ICAO Doc 10039, Manual on System Wide Information Management (SWIM) Concept
[IDD]	V1.0	FALKE Interface Definition Document
[INTEL-ODID]	0.61.1	Intel Corporation, Open Drone ID Message Specification, Draft Specification, November 13, 2018
[OASIS-SOA]	12 October 200	Reference Model for Service Oriented Architecture 1.0, OASIS Standard http://docs.oasis-open.org/soa-rm/v1.0
[OSED-CUAS]	n/a	EUROCAE ED-286 Operational Services and Environment Definition for Counter-UAS in Controlled Airspace
[UspaceArchitecturePrinciples]	Ed. 01.04	Initial view on Principles for the U-space architecture https://www.sesarju.eu/sites/default/files/documents/u-space/SESAR%20principles%20for%20U-space%20architecture.pdf
[UspaceBlueprint]	2017	SESAR-JU, U-space Blueprint, https://www.sesarju.eu/u-space-blueprint

Table 27: List of References