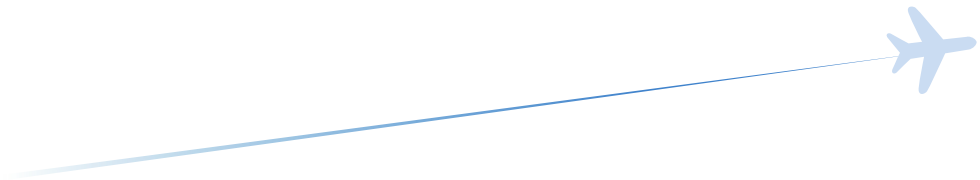

GOF2.0 D2.4 – Appendix J Weather Service Specification

Deliverable ID:	**D2.4-J**
Dissemination Level:	**PU**
Project Acronym:	**GOF2.0**
Grant:	**101017689**
Call:	**H2020-SESAR-2020-1 VLD Open 2**
Topic:	**U-space capabilities and services to enable Urban Air Mobility**
Consortium Coordinator:	**Lennuliiklusteeninduse Aktsiaselts (EANS)**
Edition Date:	**31 October 2022**
Edition:	**00.00.04**
Template Edition:	**03.00.00**

Founding Members
EUROPEAN UNION EUROCONTROL

SESAR JOINT UNDERTAKING

Authoring & Approval

Authors of the document

Name/Beneficiary	Position/Title	Date
Darshan Sathiyanarayanan / Vaisala	WP2	03.1.2022
Remy Parmentier / Vaisala	WP2	03.1.2022
Tapio Haarlaa/ Vaisala	WP2	03.1.2022

Reviewers internal to the project

Name/Beneficiary	Position/Title	Date
Gregor Mogeritsch / Frequentis	WP2	
Hubert Künig / Frequentis	WP2	
Pawel Korzec / DroneRadar	WP2	
Gokul Srinivasan / Robots Expert	WP2	
Tanel Järvet / CAFA Tech	WP2	
Thomas Lutz / Frequentis	WP2	

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

Document History

Edition	Date	Status	Author	Justification
00.00.02	24.08.2021	draft	WP2 Partners	Enhance and update
00.00.03	03.01.2022	draft	WP2 Partners	Enhance and update
00.00.04	03/11/2022	released	WP2 Partners	Release

GOF2.0

GOF2.0 INTEGRATED URBAN AIRSPACE VERY LARGE DEMONSTRATION (VLD)

This Updated Service Specification is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 101017689 under European Union's Horizon 2020 research and innovation programme.

Abstract

This specification introduces a Supplementary data service which ensures appropriate weather data is accessible in a reliable manner to all stakeholders within the U-space environment.

In accordance with ICAO SWIM, this document describes one of these supplementary data Services, the Weather data service in a logical, technology-independent manner.

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1. Overview

In order to enable safe and reliable operations at scale, drone operators need an accurate picture of the weather conditions across the airspace before the flight for operations planning, to make a go-no go decision at take-off, all along the flight duration to manage unexpected hazardous weather conditions and post-flight, for a posteriori analysis of flight conditions [1].

Supplementary Weather Data Service[1] [SWDS] is defined and implemented to supply accurate hyperlocal weather data from observations, models and forecasts to SWDS subscribers such as drone operators, USSP, ANSPs, Insurance companies and other interested parties.

SWDS aims at supporting a drone operator's weather-related risk management and flight optimization. SWDS will be used to make CARS height/altitude transformations, wherever conversion between barometric and GNSS based systems will be required.

In particular, for safety it is necessary to identify and locate areas where weather conditions are not compatible with a given UAV flight envelop and/or do not comply with predefined airspace regulations.

Presently, UAV pilots are checking various sources for regional and local weather information close to the flights' locations. Weather information sources are for example:

- Weather forecasts provided by the National Weather Service or other Public-domain weather service such as Windy, Skysight, etc.
- Nearby meteorological stations (airports…)
- METAR, TAF
- Hand-held weather station deployed that the take-off location

Such weather data sources poorly represent actual weather conditions that the drone will encounter all along its journey and the responsibility remains on the pilot to make the decision to take-off or not based upon his experience. This is exacerbated for flights inside the urban environment at or below house-roof height.

[1] Third party information provided by a Supplementary Data Service Providers (SDSP) increases knowledge of the operational flight area for a UAV with data and analysis delivered using web services.

Weather information can arise from multiple sources, it is currently up to the UAV operator / automatic UAV systems to find the weather information from different sources, synthesize and make the call on which information to trust and fly.

Thus, in this work, it is intended to provide a data structure and exchange framework to efficiently synthesize weather data from multiple sources and make them most efficiently available to the relevant entities.

This includes:

- **Construct an adapted data structure model** to provide weather data from different weather sources in a more accessible structure
- **Establish a framework for the exchange protocols** adapted to all relevant weather data types (Wind vector, Turbulence, Shear, Visibility, Temperature, etc)

1.2. Scope

The Supplementary Weather Data Service described in this document provides a general mechanism between the various stakeholders, interfaces and data models that enable and allow the automated data exchange and utilization between the respective parties.

The scope includes the following aspects:

- Operational Context
- Service Interfaces
- Service Data Model

There are a number of goals defined that this specification document aims to achieve:

1. A goal is to define the nature of the exchange protocol to communicate between a traffic management system (or drone operator, USSP or equivalent) and a weather information provider.

2. A goal is to identify architectures that will be amenable to expedient implementation by a variety of weather information providers, given that weather information providers have various weather data sources and numerical modelling capabilities.

3. A goal is to identify scalable architectures that would support a variety of business models and data sharing models in a technology independent way (i.e. limiting and avoiding exchange of proprietary and/or sensitive data) but enabling proprietary implementations of a segregated instance of the weather data service that could make use of proprietary weather information.

The overall objective is to provide a minimum set of descriptions to standardize the way data between Weather Information providers and the UTM ecosystem can be exchanged. The Weather Data Service does not limit any entity, by any means, to deploy or implement other data exchange in addition to the defined service definitions.

1.3. Intended readership

This document is intended to be read by all members of the GOF2.0 USPACE project, specifically, technical Point of Contacts (service architects, system engineers and developers) of members involved.

In general, the following entities are intended as readership:

- Air Navigation Service Providers (ANSPs)
- Civil Aviation Authorities (CAAs)
- Administrative Units
- Supplemental Data or Data Service Providers
- Drone Manufacturers
- Drone Operators
- General Aviation Operators
- Authorities
- U-space Service Provides
- U-space Infrastructure Providers

1.4. Issue context

The primary issue addressed in this document is to improve the interaction between weather data sources/service providers and UAV stakeholders to facilitate the ingestion of high-quality hyperlocal weather data.

Weather data are produced in multiple formats and sizes. Depending on the weather parameter of interest and the measurement instrument employed, the final weather data files can have varied data types and different update frequencies. This makes it difficult for non-meteorologists to exploit multiple varied sources of high-quality weather data.

Thus, it is important to explore how the different weather data types and weather service interfaces can be reworked for the benefit of UAV stakeholders.

1.4.1. General principles

A key principle of the U-space architecture is applying a service-oriented architecture approach, where open, interoperable and standard based interfaces are offered based on SWIM principles[2].

[2] Note that by SWIM principles the general concept including not only AIXM, FIXM, WIXM via SOAP are meant, but also web services / rest / messaging (JMS, AMQ) as considered in the SWIM Yellow profile [4].

2. Operational context

2.1. Overview of operational requirements

Acquiring, interpreting, and making operational decisions based on weather information is essential to safe & efficient UAV operations.

Different stages of a UAV mission will require the appropriate weather information.

- Flight preparation: Weather Forecast
- Pre-flight: Weather Forecast, Current Weather and critical Weather Alerts
- In-flight: Current Weather and critical Weather Alerts
- Post Flight: Historic weather data

The nature of weather data and the weather service interface required will vary depending on the UAV mission phase.

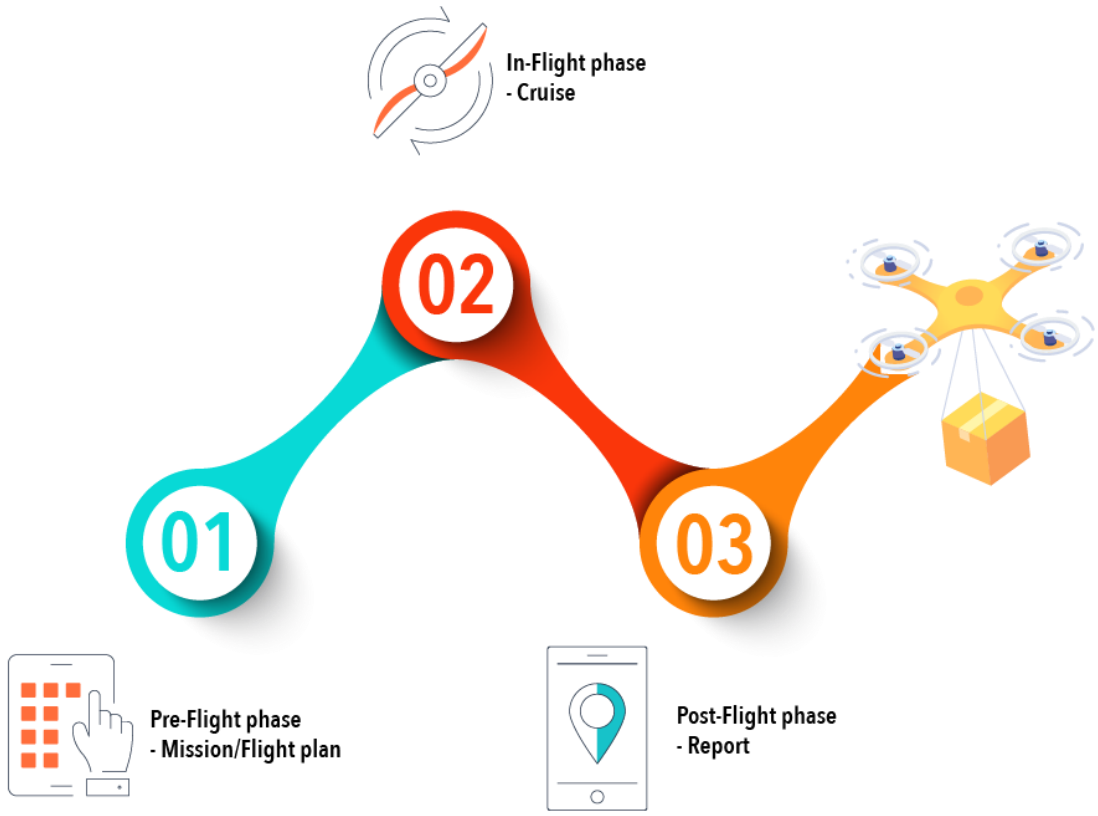

Figure 1: Operational Phases diagram

To accommodate for the different weather data and UAV operator interactions at the different UAV mission phases, the Supplementary Weather data service should provide the following capabilities:

- To push weather data
    - A regular update of current weather data in a selected domain at a requested frequency
    - An Irregular update of the current alert state in a selected domain of interest
- To allow for weather data query with input specifications from the user
    - The Historic weather data at the requested time periods
    - The Forecast weather data at the requested time horizons

The operational nature of the supplementary weather service data provider that meets these requirements is detailed in the following two chapters in this section.

2.2. Operational nodes

Operational nodes which may consume the Weather Data service include the following ones.

Operational Node	Remarks
U-space service provider	
ANSP	
UAV operator	

Table 1 : Operational Nodes

2.3. Operational Activities

Operational activities supported by the Weather Data service include the following ones.

Phase	Operational Activity	Remarks
Flight preparation	Plan	The consumer will be able to query the weather service for a weather forecast at the required time scale.
Pre-flight	Plan	The consumer will be able to query the weather service for a weather forecast at the required time scale. The Consumer will be able to get a real-time high-resolution weather data update from the weather service interface at mission critical locations (along the whole Operation Plan including alternative landing sites).
In-Flight	Take-Off	The Consumer will be able to get a real-time high-resolution weather data update from the weather service interface at mission critical locations (Take off sites).
	Cruise	The Consumer will be able to get a real time update of the Weather at a requested frequency within a domain covering the flight path, from the weather service.

	Land/Arrive	The Consumer will be able to get a real-time high-resolution weather data update from the weather service interface at mission critical locations (Landing sites).
Post-Flight	Report	The consumer will be able to query the weather service for historic weather data at given locations.

Table 2: Operational Activities supported by the Supplementary Weather Data Service

3.Service Interface overview

The weather data interface will accommodate a data subscription/publication interface and a query-based interface. The former is meant to transfer regular data and weather alerts. The latter serves to transfer weather data that need to be queried at each instance with user specific input parameters (ex: weather forecasts).

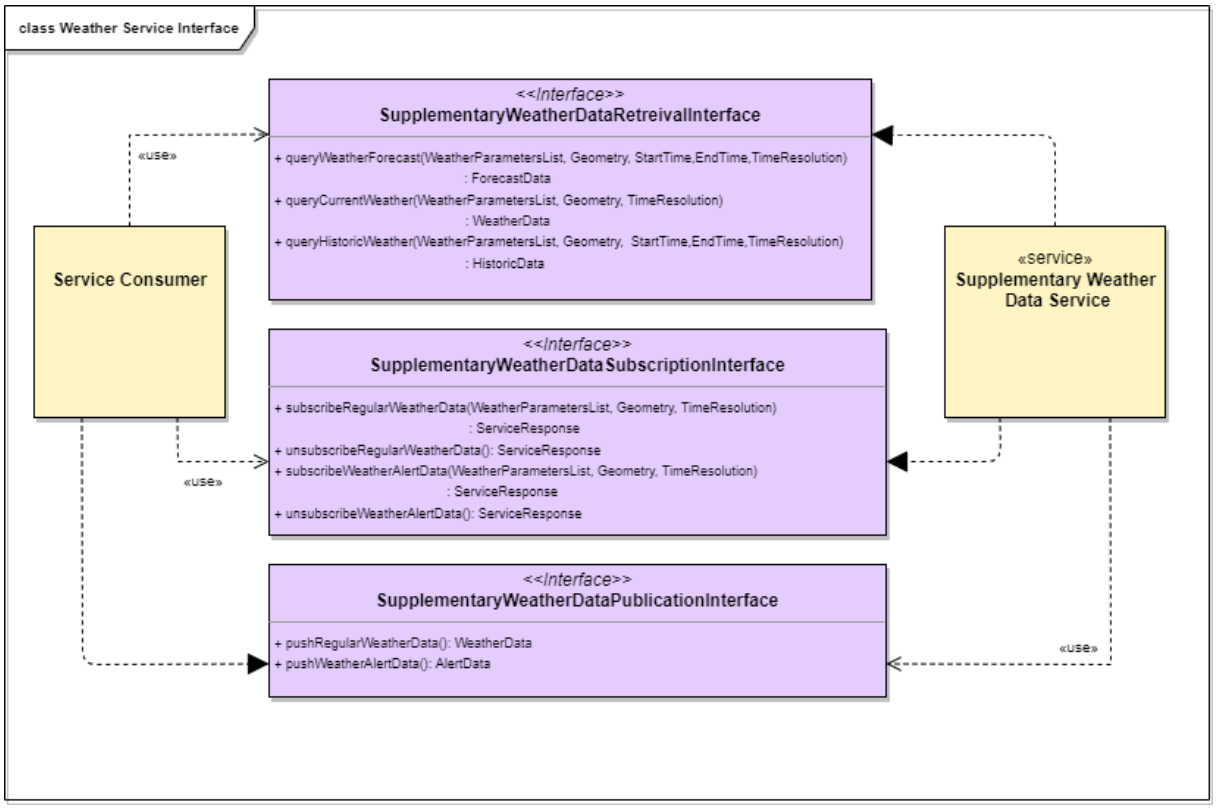

Figure 2: Service Interface Overview

ServiceInterface	Role (from service provider point of view)	ServiceOperation

SupplementaryWeatherDataRetrievalInterface	Provided	queryWeatherForecast queryCurrentWeather queryHistoricWeather
SupplementaryWeatherDataSubscriptionInterface	Provided	subscribeRegularWeatherData unsubscribeRegularWeatherData subscribeWeatherAlertData unsubscribeWeatherAlertData
SupplementaryWeatherDataPublicationInterface	Used	pushRegularWeatherData pushWeatherAlertData

Table 3: Service Interfaces

4. Service Data Model

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

4.1. Overview

Weather data comprises of the information pertaining to multiple different parameters of the environment. For example, wind, temperature, visibility, lightning, fog, rain, Humidity, Icing etc.

However, weather data from different sources can vary in terms of spatial and temporal characteristics. Thus, it becomes important to find a way to harmonize at least the spatial indexation of this data, to make it easier to ingest (and appropriately average or regroup weather data points in time).

The wind for example can be measured either by an anemometer -at one location at high frequency- or through a Weather radar – at multiple locations at a lower frequency-. On one hand the high frequency data could be more useful to optimize take-off and landing at the vertiport. And on the other hand, the volumetric measurement of the wind field can be more useful to plan the flight trajectory itself. Thus, a common data structure able to accommodate weather data that is spatially and temporally distributed must be used.

Practically, each data file could be reformatted into a voxel grid format. Thus, each measurement, be it from any instrument at any position can be allocated to a certain voxel in space.

The Weather data will be allocated to a 3D cartesian grid.

This grid will divide the space into cuboids, with a given horizontal dimension and a given vertical dimension. (A parameter that can be varied by the consumer).

Each weather data file received from a different weather source will have to be first formatted to incorporate this spatial referencing (allocated to the corresponding cuboid in which it is placed).

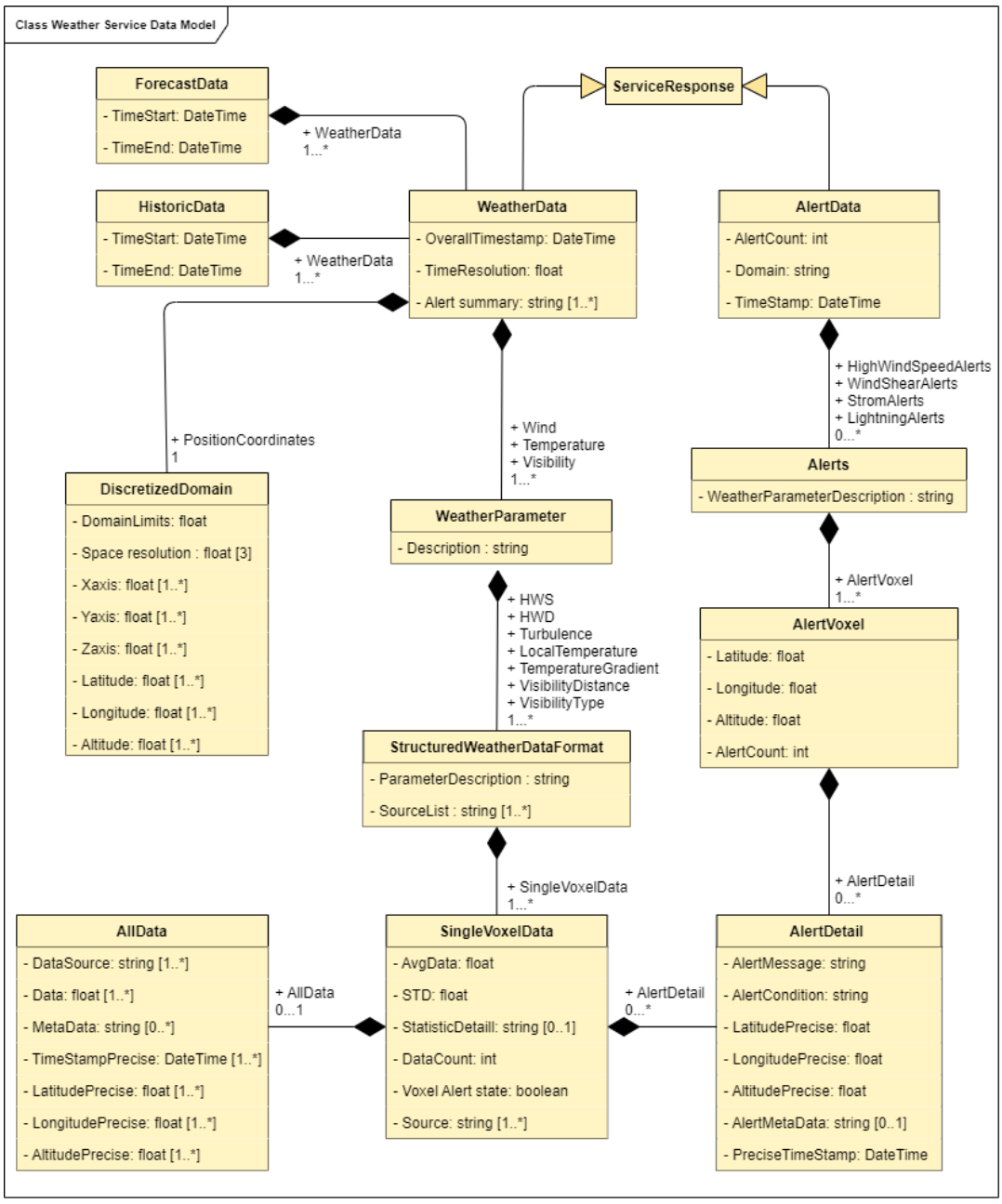

Figure 3: Data model Overview

4.2. The WeatherData Data Structure

Property	Type	Multiplicity	Description	Note
OverallTimestamp	DateTime	1	A time stamp corresponding to the time period of the provided data. The TimeStamp contains the value of the time at the end of each time period/bin.	The time period used here is given by the TimeResoution.
TimeResolution	Float	1	The time between two consecutive regular weather updates.	The minimum time resolution is inversely linked to the domain size. (to avoid flooding the receiver with high frequency updates of large files).
AlertSummary	String	1..*	A sequency of strings containing a summary of the different alerts for each weather parameter chosen.	
Wind	WeatherParameter	0..1	A Weather parameter containing voxel structured information on the different variables pertaining to Wind. (HorizontalWindSped, HorizontalWindDirection, Turbulence)	Further variables can be added to expand information provided in the wind.

Temperature	WeatherParameter	0..1	A Weather parameter containing voxel structured information on the different variables pertaining to Temperature. (LocalTemperature, TemperatureGradient)	Further variables can be added to expand information provided in the temperature.
Visibility	WeatherParameter	0..1	A Weather parameter containing voxel structured information on the different variables pertaining to Visibility. (VisibilityType, VisibilityDistance)	Further variables can be added to expand information provided in the visibility.

Table 4: WeatherData Data Structure

4.3. The HistoricData Data Structure

Property	Type	Multiplicity	Description	Note
TimeStart	DateTime	1	A time stamp corresponding to the start of the historic weather data requested.	
TimeEnd	DateTime	1	A time stamp corresponding to the end of the historic weather data requested.	The minimum time resolution is inversely linked to the domain size. (to not flood too the bandwidth with high frequency updates of large files).

WeatherData	WeatherData	1..*	Multiple WeatherData corresponding each to a time period.	Each of the WeatherData contains all information on the state of the weather for a given time period.

Table 5: HistoricData Data Structure

4.4. The ForecastData Data Structure

Property	Type	Multiplicity	Description	Note
TimeStart	DateTime	1	A time stamp corresponding to the start of the forecast weather data requested.	
TimeEnd	DateTime	1	A time stamp corresponding to the end of the forecast weather data requested.	The minimum time resolution is inversely linked to the domain size. (to not flood too the bandwidth with high frequency updates of large files).
WeatherData	WeatherData	1..*	Multiple WeatherdData corresponding each to a time period.	Each of the WeatherData contains all information on the state of the weather for a given time period.

Table 6: ForecastData Data Structure

4.5. The WeatherParameter Data StructureS

Property	Type	Multiplicity	Description	Note

Description	String	1	A description of the group weather parameter: ex: Wind, Temperature, Visibility, etc	It should describe the group weather parameter and not the sub weather parameter.
HWS	StructuredWeatherData	0..1	The HorizontalWindSpeed provided in a voxel structured format for a given time period.	The HorizontalWindSpeed is provided in the Wind WeatherData structure.
HWD	StructuredWeatherData	0..1	The HorizontalWindDirection provided in a voxel structured format for a given time period.	The HorizontalWindDirection is provided in the Wind WeatherData structure.
Turbulence	StructuredWeatherData	0..1	The Turbulence provided in a voxel structured format for a given time period.	The Turbulence is provided in the Wind WeatherData structure.
LocalTemperature	StructuredWeatherData	0..1	The LocalTepmerature provided in a voxel structured format for a given time period.	The LocalTemperature is provided in the Temperature WeatherData structure.
TemperatureGradient	StructuredWeatherData	0..1	The TemperatureGradient provided in a voxel structured format for a given time period.	The TemperatureGradient is provided in the Temperature WeatherData structure.

VisibilityType	StructuredWeather Data	0..1	The VisibilityType provided in a voxel structured format for a given time period.	The VisibilityType is provided in the Visibility WeatherData structure.
VisibilityDistance	StructuredWeather Data	0..1	The VisibilityDistance provided in a voxel structured format for a given time period.	The VisibilityDistance is provided in the Visibility WeatherData structure.

Table 7: WeatherParameter Data Structure

4.6. The StructuredWeatherData Data Structure

Property	Type	Multiplicity	Description	Note
ParameterDescription	String	1	A description of the weather parameter is provided. This will include the units used.	It should describe the sub weather parameter and not simply the weather group. For example, it should describe the Turbulence and not simply the Wind.
SourceList	String	1..*	A sequence of strings listing the different weather data sources used for the given weather parameter.	The list is unique.

SingleVoxelData	SingleVoxelData	1..*	A 3D array with each data point providing all weather information within a voxel in the SingleVoxelData structure.	The 3D array indexation should correspond to the indexation used for the domain discretization. This allows to find the position of each voxel using the DiscretisedDomain variable.

Table 8: StructuredWeatherData Data Structure

4.7. The SingleVoxelData Data Structure

Property	Type	Multiplicity	Description	Note
AvgData	float	1	Provides the averaged value of a given weather parameter within a voxel during the given time period.	The AvgData in certain cases can also be replaced by the most representative value of a weather parameter within the given voxel. This also allows for quality filters to be applied during the averaging.
STD	float	1	Provides the StandardDeviation of the averaged data.	
StatisticDetail	string	0..1	Provides Details on the averaging and Standard Deviation computation.	This allows for transparency in the filtering performed. This information can be opted out to improve file size.
DataCount	int	1	The number of available data points within a voxel.	

VoxelAlertState	boolean	1	The VoxelAlertState shows state 1 if at least one alert is present within the given voxel. And 0 otherwise.	
Source	string	[1..*]	A list of data sources used within a given voxel.	This list is unique.
AllData	AllData	[0..1]	All data points within a voxel (non-averaged at least in space) are provided.	This data can be opted out, to keep file sizes manageable. This data is useful for certain given locations where it is necessary to have the raw weather data, with least processing. This data can be opted out through a parameter provided in the subscription operation.
AlertDetail	AlertData	[0..*]	Detailed Alert information within a voxel during the given time period is provided in the AlertDataStructure.	Each individual Alert will be held in a different AlertDetial variable.

Table 9: SingleVoxelData Data Structure

4.8. The AllData Data Structure

Property	Type	Multiplicity	Description	Note

DataSource	String	[1..*]	An array of strings providing the source of the corresponding individual data point.	The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.
Data	Float	[1..*]	An array of float providing the raw data information.	The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.
MetaData	String	[0..*]	An array of strings providing meta data for the corresponding individual data point. (This could be instrument specific measurement points)	This variable may be removed depending on the weather parameter used. The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.
TimeStampPrecise	DateTime	[1..*]	An array of DateTime providing the individual data TimeStamp information.	The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.
LatitudePrecise	Float	[1..*]	An array of Float providing the individual data precise latitude position information.	The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.

LongitudePrecise	Float	[1..*]	An array of Float providing the individual data precise longitude position information.	The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.
AltitudePrecise	Float	[1..*]	An array of Float providing the individual data precise Altitude position information.	The indexation is common with the Data variable within this data structure. Each index along the array corresponds to an individual measurement.

Table 10: AllData Data Structure

4.1. The DiscretizedDomain Data Structure

Property	Type	Multiplicity	Description	Note
DomainLimits	Float	1	The bounds of the domain for the weather data to be provided in.	The Domain limits max size is linked to the space resolution chooses. (to keep the size of each data file manageable)
SpaceResolution	Float	3	The X, Y and Z resolution corresponding to the size of each voxel within the discretised domain. Unit in Meters.	
Xaxis	Float	1..*	A 3D array containing the Xaxis position of the centre of each voxel. Unit used in meters.	The Xaxis is centred within the chosen domain.
Yaxis	Float	1..*	A 3D array containing the Yaxis position of the centre of each voxel. Unit in meters.	The Yaxis is centred within the chosen domain.

Zaxis	Float	1..*	A 3D array containing the Zaxis position of the centre of each voxel. Unit in meters.	The Zaxis is centred within the chosen domain.
Latitude	Float	1..*	A 3D array containing the Latitude position of the centre of each voxel.	The coordinate system used is WGS84.
Longitude	Float	1..*	A 3D array containing the Longitude position of the centre of each voxel.	The coordinate system used is WGS84.
Altitude	Float	1..*	A 3D array containing the Altitude position of the centre of each voxel. Unit in meters.	The coordinate system used is WGS84. And altitude is provided AMSL.

Table 11: DiscretizedDomain Data Structure

4.2. The AlertDetail Data Structure

Property	Type	Multiplicity	Description	Note
AlertMessage	String	1	Provides the alert level, with the relevant description.	
AlertCondition	String	1	Provides the Alert condition met.	This will include the multiple Alert conditions for different alert levels as well.
LatitudePrecise	Float	1	A float containing the exact Latitude of the data point corresponding to the alert.	Latitude Precise provides the position of the raw measured data points within a voxel. This is in contrast to Latitude (found in the DiscretisedDomain data structure).

LongitudePrecise	Float	1	A float containing the exact Longitude of the data point corresponding to the alert.	Longitude Precise provides the position of the raw measured data points within a voxel. This is in contrast to Longitude (found in the DiscretisedDomain data structure).
AltitudePrecise	Float	1	A float containing the exact Altitude of the data point corresponding to the alert.	Altitude Precise provides the position of the raw measured data points within a voxel. This is in contrast to Altitude (found in the DiscretisedDomain data structure).
AlertMetadata	String	0..1	A string containing particular metadata relevant to the Alert.	
PreciseTimeStamp	DateTime	1	A DateTime containing the exact TimeStamp of the data point corresponding to the alert.	The precise Time stamp corresponds to the exact time (high resolution) of alert measurement/occurrence. This is in contrast to the "TimeStamp" provided in the AlertData variable that corresponds to the end of each 1 second bins used as the update frequency.

Table 12: AlertDetail Data Structure

4.3. The AlertVoxel Data Structure

Property	Type	Multiplicity	Description	Note

Latitude	Float	1	The Latitude of the Centre of the voxel containing the alert.	
Longitude	Float	1	The Longitude of the Centre of the voxel containing the alert.	
Altitude	Float	1	The Altitude of the Centre of the voxel containing the alert.	
AlertCount	Int	1	Provides the number of alerts within a given voxel.	
AlertDetail	AlertDetail	0..*	Details about each alert in AlertDetail format.	

Table 13: AlertVoxel Data Structure

4.4. The Alerts Data Structure

Property	Type	Multiplicity	Description	Note
WeatherParameterDescription	String	1	Describes the weather parameter used to create the alert.	
AlertVoxel	AlertVoxel	1..*	Multiple Alert voxels, containing each information about the alerts within each given voxel.	Only Voxels with an alert are provided.

Table 14: Alerts Data Structure

4.5. The AlertData Data Structure

Property	Type	Multiplicity	Description	Note
AlertCount	Int	1	The total number of alerts in a given update.	

Domain	Float	3	The dimensions and spatial resolution of the domain of interest.	
TimeStamp	DateTime	1	The time stamp of the alerts update.	Provided at 1 second steps.
HighWindSpeedAlerts	Alerts	0..1	All Alerts at a given instance pertaining to Wind speed going beyond a threshold.	
WindShearAlerts	Alerts	0..1	All Alerts at a given instance pertaining to Wind shear going beyond a threshold.	
StormAlerts	Alerts	0..1	All alerts at a given instance about storms in the alerts format.	
LightningAlerts	Alerts	0..1	All alerts within the given domain providing lightning alerts.	

Table 15: AlertData Data Structure

4.6. Common data structures used in U-space specifications

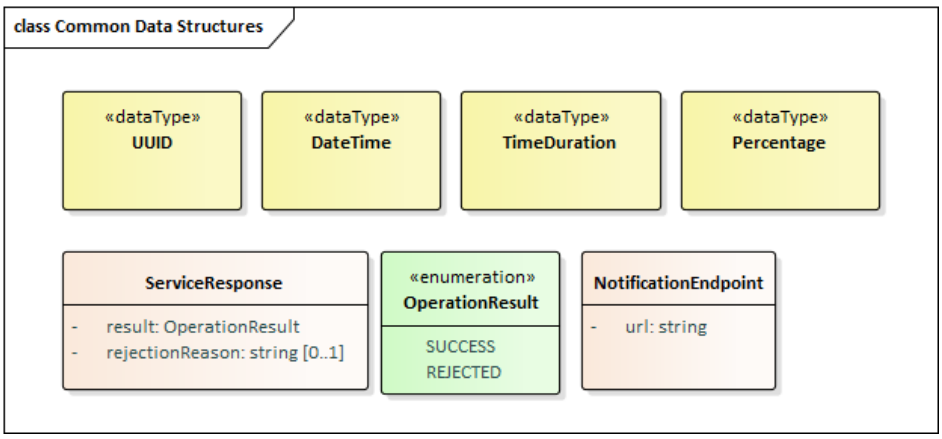

Figure 4: Common Data Types Used in U-space Service Specifications

4.6.1. *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	Multi-plicity	Description	Note
result	*Oper-ation-Result*	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 16: ServiceResponse Data Structure

5.Service Interface specifications

This chapter describes the details of each service interface. One sub-chapter is provided for each Service Interface.

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

5.1. Service Interface

5.2. SupplementaryWeatherDataretrievalInterface

The supplementary Weather Data Retrieval Interface allows service consumers to retrieve weather data on request. (Historic, Current and Forecast weather data)

5.2.1. Operation queryWeatherForecast

1.1.1.1 Operation Functionality

Returns a ForecastData file containing the weather forecast for the time indicated by the input timestamp.

1.1.1.2 Operation Parameters

Parameter Name	Direction	Data Type	Description
WeatherParametersList	Input	WeatherParametersList	List of Weather Parameters requested.
Geometry	Input	Geometry	The extent of the spatial domain and the spatial resolution of the output data.
StartTime	Input	DateTime	The start time of the requested weather data.

EndTime	Input	DateTime	The end time of the requested weather data.
TemporalResolution	Input	Float	The temporal resolution of the requested weather data. (in seconds)
ForecastData	Return	ForecastData	Query response, including the requested forecast Weather data.

Table 17: Operation queryWeatherForecast parameters

5.2.2. Operation queryCurrentWeather

1.1.1.3 Operation Functionality

Returns a WeatherData file containing the current weather data at the time of request.

1.1.1.4 Operation Parameters

Parameter Name	Direction	Data Type	Description
WeatherParametersList	Input	WeatherParametersList	List of Weather Parameters requested.
Geometry	Input	Geometry	The extent of the spatial domain and the spatial resolution of the output data.
WeatherData	Return	WeatherData	Query response, including the requested current Weather data.

Table 18: Operation queryCurrentWeather parameters

5.2.3. Operation queryHistoricWeather

The Historic data service interface will allow the UAV operator/USSP to use an API command to query historic weather data from the weather data base. The user will be able to query weather data for past dates /times as per requirement.

1.1.1.5 Operation Functionality

Returns a HistoricData file containing the weather data corresponding to the requested time frame in the past.

1.1.1.6 Operation Parameters

Parameter Name	Direction	Data Type	Description
WeatherParametersList	Input	WeatherParametersList	List of Weather Parameters requested.
Geometry	Input	Geometry	The extent of the spatial domain and the spatial resolution of the output data.
StartTime	Input	DateTime	The start time of the requested weather data.
EndTime	Input	DateTime	The end time of the requested weather data.
TemporalResolution	Input	Float	The temporal resolution of the requested weather data. (in seconds)
HistoricData	Return	HistoricData	Query response, including the requested historic Weather data.

Table 19: Operation queryHistoricWeather parameters

5.3. Service Interface SupplementaryWeatherDataSubscriptionInterface

Allows service consumers to subscribe/unsubscribe for reception of weather data publications

5.3.1. Operation subscribeRegularWeatherData

1.1.1.7 Operation Functionality

A consumer calls this operation to subscribe to Regular Weather Data.

1.1.1.8 Operation Parameters

Parameter Name	Direction	Data Type	Description
WeatherParametersList	Input	WeatherParametersList	List of Weather Parameters requested.
Geometry	Input	Geometry	The extent of the spatial domain and the spatial resolution of the output data.
TemporalResolution	Input	Float	The temporal resolution of the requested weather data. (in seconds)
ServiceResponse	Return	ServiceResponse	Provide status information on subscription.

Table 20: Operation subscribeRegularWeatherData parameters

5.3.2. Operation unsubscribeRegularWeatherData

1.1.1.9 Operation Functionality

A consumer calls this operation to unsubscribe to Regular Weather Data.

1.1.1.10 Operation Parameters

Parameter Name	Direction	Data Type	Description

ServiceResponse	Return	ServiceResponse	Provide status information on subscription.

Table 21: Operation unsubscribeRegularWeatherData parameters

5.3.3. Operation subscribeWeatherAlertData

1.1.1.11 Operation Functionality

A consumer calls this operation to subscribe to Weather Alert Data.

1.1.1.12 Operation Parameters

Parameter Name	Direction	Data Type	Description
WeatherParametersList	Input	WeatherParametersList	List of Weather Parameters requested.
Geometry	Input	Geometry	The extent of the spatial domain and the spatial resolution of the output data.
TemporalResolution	Input	Float	The temporal resolution of the requested weather data. (in seconds)
ServiceResponse	Return	ServiceResponse	Provide status information on subscription.

Table 22: Operation subscribeWeatherAlertData parameters

5.3.4. Operation unsubscribeWeatherAlertData

1.1.1.13 Operation Functionality

A consumer calls this operation to unsubscribe to Weather Alert Data.

1.1.1.14 Operation Parameters

Parameter Name	Direction	Data Type	Description
ServiceResponse	Return	ServiceResponse	Provide status information on subscription.

5.4. Service Interface SupplementaryWeatherDataPublicationInterface

Supplementary Weather Data Service to publish (push) real time weather data to subscribed consumers through this interface.

5.4.1. Operation pushRegularWeatherData

1.1.1.15 Operation Functionality

Publishes WeatherData file updates at a regular frequency containing current weather information.

1.1.1.16 Operation Parameters

Parameter Name	Direction	Data Type	Description
WeatherData	Return	WeatherData	A regular push of the requested weather data corresponding to subscription

Table 23: Operation pushRegularWeatherData parameters

5.4.2. Operation pushWeatherAlertData

Certain types of measurements such as wind shear and storms require real time alerts to be communicated with the stakeholders. Thus, there will be made available an irregular data push. The idea is to communicate an alert immediately after an alert grade phenomenon has been observed.

1.1.1.17 Operation Functionality

Publishes Weather AlertData file updates at a regular frequency containing current weather alert information.

1.1.1.18 Operation Parameters

Parameter Name	Direction	Data Type	Description
AlertData	Return	AlertData	A high frequency irregular push of the requested alert data corresponding to subscription.

Table 24: Operation pushWeatherAlertData parameters

6.Service Dynamic Behavior

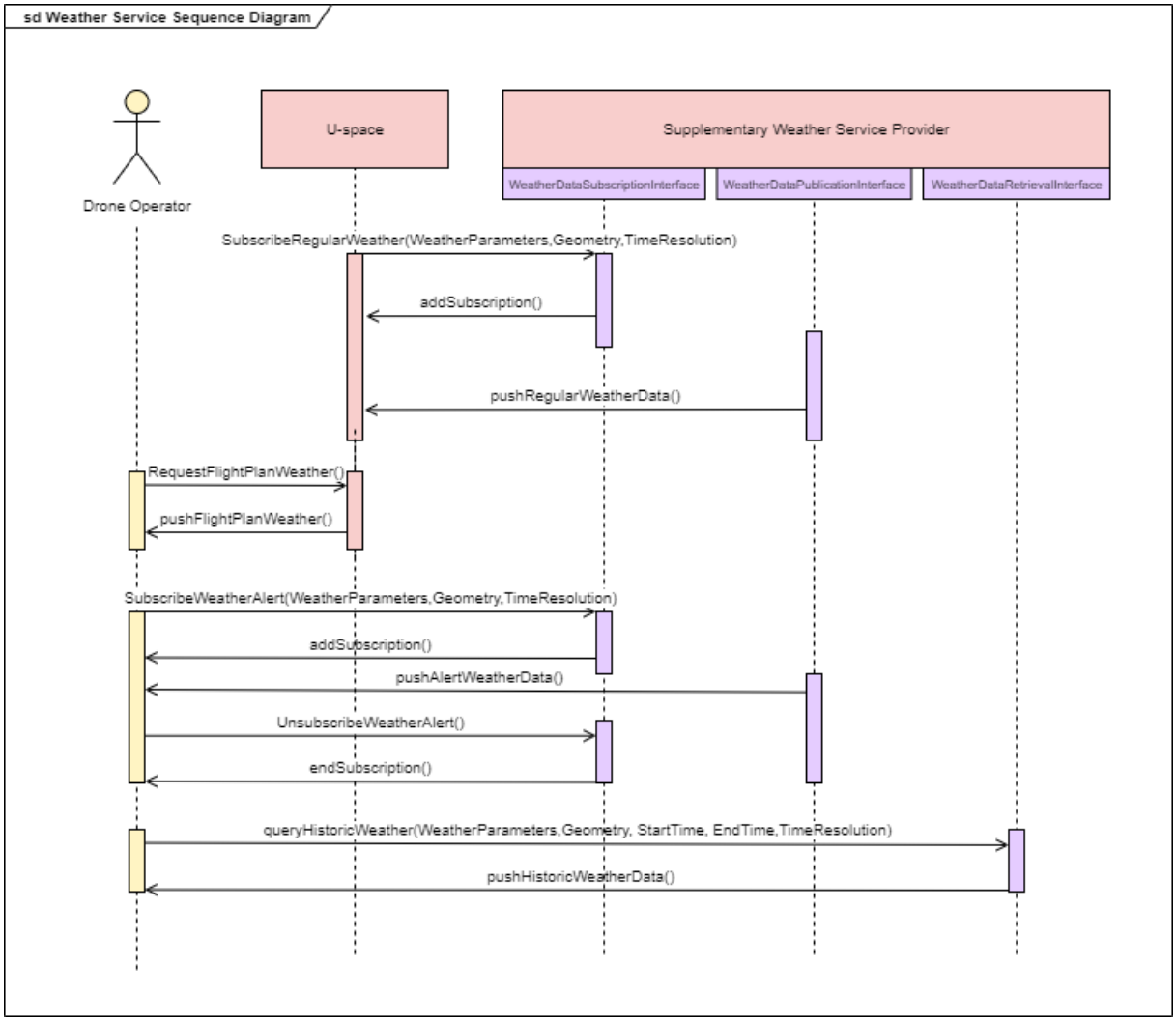

Figure 5: Service Dynamic Behavior

The figure above provides an example scenario for the Supplementary Weather data service.

The following three Scenarios are illustrated in the above diagram:

- U-space Regular weather data update and dispatch to UAV operators
- UAV operators subscribe to weather alerts
- UAV operator query for Historic and Forecast data.

7. Definitions of Acronyms and Terms

7.1.1. List of Acronyms

Acronym	Explanation
3GPP	3rd Generation Partnership Project
ACJA	Aerial Connectivity Joint Activity (by GSMA + GUTMA)
AIXM	Aeronautical Information Exchange Model
AMQ	Advanced Message Queuing
API	Application Programming Interface
ASTM	American Society for Testing and Materials
ATM	Air Traffic Management
BVLOS	Beyond Visual Line of Sight
CARS	Common Altitude Reference System
C2	Command and Control
CIS	Common Information Service
CTR	Controlled Traffic Region
EDT	Estimated Time of Departure
FIXM	Flight Information Exchange Model
FPL	Flight Plan
GSMA	GSM Association
GUTMA	Global UTM Association
SSD	Service Specification Document
SWIM	System Wide Information Management
UAM	Urban Air Mobility
U-space	Concept of procedures and services to support unmanned traffic management
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
USSP	U-space Service Providers

Acronym	Explanation
UTM	UAV Traffic Management

8. References

Nr.	Version	Reference
[1]		*European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace* https://www.sesarju.eu/node/2993