This document has been assembled as a question and answer sheet for the technical aspects of the Aventus NowCast Service. It is designed to be as complete as possible while also being brief. The service consists of three separate services (climb, cruise, and descent) and, where applicable, the document will break down functionality per the different service if not specified then it should be assumed the functionality applies across all the service levels.
The Aventus NowCast system generates its benefits on two unique pillars; high quality weather data and patented wind and level selection algorithms. Each pillar will be broken down regarding its benefits and operation.

**HIGH QUALITY WEATHER DATA**

*Where does weather information for Aventus NowCast come from?*

Over the last five years, AVTECH has performed an exhaustive due diligence on the global meteorology-industry in a quest to provide the very best in weather information to our customers. As a result of this due diligence work, AVTECH are delighted to partner with the Met Office as their first choice weather forecast provider.

The Met Office has been at the forefront of global weather and climate science for over 160 years. The Met Office is committed to combining the latest science with ground breaking advances in technology and local understanding to deliver operational advantage to all sectors of the aviation industry.

Aircraft Meteorological Data Relay, (AM DAR), observations are utilised within the Met Office's data assimilation process. The observations of wind and temperature are combined with a previous weather forecast to obtain the best estimate of current atmospheric conditions. This is evolved forward in time by the forecast model to produce the next forecast which should be a close reflection of the new weather conditions.

The Met Office’s new £97M supercomputer will be used to turn research into highly detailed operational forecasts and services for their users. More detailed forecasts will make it possible to predict small-scale, high impact weather features with greater skill and accuracy which should continue to increase as technology advances.

*What is the quality of the Weather provided by the Aventus system and how does this compare to the industry Standard?*

The current qualities are as shown at bottom.

Many flight planning suppliers and most aviation Met organizations currently use the World Area Forecast Model which is produced to an ICAO specification by state Met providers. In many cases these state Met suppliers have high resolution weather models whose qualities exceed the ICAO specification thus the model is essentially downgraded in order to comply.

*What benefits do enhanced weather products have over basic World Area Forecast model data?*

There is plenty of anecdotal evidence that higher resolution models provide better forecasts, but surprisingly it is difficult to find published papers which present this in a simple way - this may be because it is so well understood in the meteorological community that no effort has been expended on proving it. AVTECH has the view that higher resolution data particularly benefits short haul operators as more of the local detail affecting a flight is then captured, or differently put, as the ascent and descent phases are then a relatively larger part of each flight (i.e. flying though the more active areas of the atmosphere). The lack of published papers is probably due to the fact that the industry is struggling to find a scientific method to isolate and quantify the value of the individual factors that affect flights. AVTECH is, as far as we are aware the only player that has a credible and robust method of quantifying the value related to improved wind and temperature data input for individual flights, however the performance of the optimization algorithm is
obviously also crucial for how efficiently an increased quality of weather will be transformed into actual benefits. AVTECH has performed several studies on how the quality of different weather and algorithms translate into benefits for different A/C-types, and we’ve seen benefits on average in the range of 10-90 kg’s per descent for medium sized jet aircraft. However, these studies focus on comparisons against FMS usage where no wind entries are made the airline.

**SELECTION ALGORITHMS**

**FMS logic**

FMS logic in respect to utilizing wind information varies between different manufacturers. However, the basic logic is that the FMS will interpolate linearly between points (altitudes) of wind inputs. If e.g. no wind information is entered by the flight crew for descent, the FMS will use actual wind at the cruising altitude and then make a linear interpolation, expecting calm wind on the ground. Due to this logic, and the fact that FMS design only allows the flight crew to enter wind information on a restricted number of altitudes, the accuracy of the FMS calculation is heavily dependent of correct and adequate inputs. Low quality wind information simply does not allow the FMS to calculate an optimized descent trajectory.

**Four dimensional trajectory (4DT)**

The Aventus system requires a 4 dimensional trajectory (4DT) from the aircraft in order for the system to operate. The Smiths/GE FMS found within the B737NG series aircraft have a unique feature in which it can export the full 4DT over the AOC datalink. Other flight management systems do not allow for extraction of a 4DT’s. By use of a standard ACARS report containing position-, flight plan-, performance-, and destination-elements, the 4DT can be accurately generated by the Aventus system. These downlinked parameters are all fed into our Trajectory Engine (“In house FMS”) which then computes the 4DT. Additionally, the inbound procedures of the airport of approach is compared to the 4DT and using standard industry nav database any procedural constraints for an airport is added to the 4DT, thereby creating an electronic image of the planned flight that can be utilized in Aventus calculations. Outside of the listed FMS-reports (all of whom are STD ACARS reports) no additional trajectory information is required.

**Static versus dynamic selection of wind level**

**Uplinks during descent**

Up to now, the standard crew wind uplinking (or information brought by paper, iPads etc.) has been a static selection of wind information in regard to the altitudes entered in the FMS. The idea has been that the variation in the chosen altitudes would represent an acceptable variation and supply the FMS with sufficient information.

Avtech has through extensive research been able to prove that selecting wind information at fixed interval rarely, if ever, will supply the FMS with sufficient data, and are therefore establishing a new standard in this area of the industry. By utilizing a 4DT, which is then in turn inserted into a detailed grid of wind data and subsequently run with a multitude of calculations, has instead shown that the wind information cannot not be a function of altitude if the FMS forecasted trajectory during descent shall come anywhere near the actual trajectory flown. The wind information inserted into the FMS must, instead, reflect wind direction.
and strength at those altitudes that provide the best representation of the total wind profile in the FMS and must therefore be selected dynamically. In practice this means that wind information at different altitudes must be used on different days or even on different flights on the same day, if an optimized calculation is the desired output from the FMS.

**How are Wind Uplink levels selected?**
The AVTECH Aventus system has a unique understanding of the range of FMS systems found within different airline operations. The Aventus system understands how different FMS's will interpolate winds entered into the FMS, as well as the number of wind fields that are available within that specific FMS. Depending on the phase of flight the winds levels are selected in the following ways:

**Enroute:**
Flight crew can request an enroute wind Uplink at any point in the flight. This request will initialize a sequence which will download a list of way point currently active within the aircrafts FMS. Once the request is received by Aventus, the system will request additional information from the FMS including additional performance and flight plan information which will help the system in determining the ETA at each downlinked waypoint. This process is all performed by AVTECH's proprietary built trajectory engine which will create a 4 dimensional trajectory from flight plan and performance data.

Aventus will then Uplink appropriate weather forecast for each waypoint along a path and for the requested altitudes. Additionally, if only one flight level is requested Aventus will automatically Uplink additional and appropriate levels to support optimal flight level selection internal to the FMS.

**Climb and Descent:**
At a certain point of time ahead of an individual aircraft’s climb or Top Of Descent (which can be predefined and modified at the request of the customer), the Aventus system downloads the trajectory, or if the FMS does not have the ability to export full trajectories a set of standard reports to build the 4DT. The data for a particular flight is used with the associated high quality weather grid and, through a complex
algorithm set, the system executes a multitude of calculations to identify the possible options of optimum descent winds to return to the aircraft based on FMS functionality. Overall, and simplified, the algorithm selects the best combination of wind levels that will lead the FMS to most closely interpret the forecasted atmospheric profile based on the performance of an individual aircraft.

How are selected wind levels optimized to take into account the specific capability of the FMS?

**Enroute:**
Apart from an improved weather forecast and usage of the current actual flight plan information no specific optimization is conducted however if no additional levels are selected by the crew the most suitable adjacent flight levels (based on FMS type and flight level) can also be automatically selected and Uplinked to the aircraft.

**Climb and Descent:**
The system understands individual FMS limitations and capabilities and these are taken into account within the calculation. For example, if the FMS has a limitation of having all descent information X distance prior to TOD, the system will take this in to account within its workflow. It also knows the number of winds the FMS is capable of taking within the descent and will pick and send the optimal selection for that number of levels.

The Aventus system also understands how the FMS is performing its wind calculation based on the information provided thus ensuring Aventus send the best winds possible in order to ensure an exact calculation of the full wind profile.

What aircraft Intent information is required by the Aventus system?
The Aventus system requires a 4 dimensional trajectory (4DT) from the aircraft in order for the system to operate. The Smiths/GE FMS found within the B737NG series aircraft have a unique feature in which it can export the full 4DT over the AOC datalink. Other flight management systems do not allow for extraction of 4DT’s, however by requesting a report containing position-, flight plan-, performance-, and destination-elements the 4DT can be accurately generated by the Aventus system.

What if my FMS is not connected to my CMU?
The Aventus AIR service allows winds forecast to be sent directly to the ACARS printer when requested by crews. A service which requires less aircraft technical requirements than other Aventus service offerings.
**What benefits does aircraft intent information add to the Aventus product?**

Two benefits are derived from having intent information:

1. As our weather information is of a higher resolution than the WAFS it is important to have an exact idea where the aircraft will be traveling on its descent. Knowing if the aircraft is coming from the North or South, turning left or right can have a big impact on winds sent to the aircraft especially during frontal passages or active weather systems.

2. The 4DT will also provide the time when the aircraft will be traveling at any point on the trajectory. As our weather is updated more often and the temporal resolution is higher than the WAFC it is important for Aventus to know the time it will be traveling through the area in order to select the appropriate forecast.

**What benefits does Aventus bring other than Fuel Savings?**

Outside fuel savings Aventus provides the following benefits:

- Reduction in Operational Variance: Aventus ease of use will allow for an easy integration in Airline SOP.
- Ease of Use and Crew Offload: Aventus automatically starts the optimization workflow, with no crew interaction required and will automatically load the descent winds into the FMS. Flight crew will, however, always have the option to accept or reject the suggested Uplink.
- Increased Accuracy when flying time based operations
- Environmental savings; saved fuel means a reduced CO2 footprint

**How does AVTECH calculate benefits pertaining to Aventus?**

AVTECH main source of benefit analytics is its own “Aventus Benefit Methodology”, developed together with major airlines in the United States. The methodology focuses on the additional costs of operating with wind errors within FMS’s. Thus, the methodology compares the wind error (Delta between the Aventus forecast with the actual wind profile experienced by aircraft). The methodology also look at the difference in wind error between wind information currently in use in the Airline (automatic Uplink or flight crew manual entries) and the actual winds recorded.

AVTECH’s trajectory engine has been used to calculate the fuel penalty associated with dif-
ferent wind errors. This information relates to aircraft type, gross weight and Top-Of-Descent altitude along with actual performance models for the specific aircraft (utilizing manufacture performance tables). The found delta difference in wind error is then connected to a benefit/penalty quantified in kilos of jet fuel.

What baseline capability is attributed to the FMS in your assessment of benefits?

AVTECH’s belief is that the FMS is the best tool for doing the job assigned to it. The basic principle of Aventus is to provide the FMS with better data in order for it to do its job better. Within our benefits analysis we look at the quality of data we are giving to the FMS, but we also evaluate wind error with the idea that less wind error equates to better predictability, a reduction in variance and in turn a lower fuel burn, thus no base line capabilities need to be factored into the analysis as our process is independent of these capabilities.

How are the effects of ATC factored into any benefit estimation?

AVTECH’s trajectory engine has been used to calculate the fuel penalty associated with different wind errors. This information relates to aircraft type, gross weight and Top-Of-Descent altitude along with actual performance models for the specific aircraft (utilizing manufacture performance tables). The found delta difference in wind error is then connected to a benefit/penalty quantified in kilos of jet fuel.

AVTECH does not calculate any benefits below 10000ft, as ATC interference is too common below this altitude. It should be noted, though, that wind information supplied to the FMS must utilize wind levels all the way to the ground in order to be correct.