SUMMARY
This paper aims at updating the ICAO AMOFSG 9th meeting on the latest progress of the development of Meteorological Services in the Terminal Area (MSTA) and requesting MET authorities and aviation user communities to contribute actively to this work, through provision of feedback and suggestions.

1. INTRODUCTION

1.1 The new Meteorological Services in the Terminal Area (MSTA) initiative, which is being undertaken by the World Meteorological Organization (WMO) in close collaboration with the International Civil Aviation Organization (ICAO), aims at providing meteorological services to support Air Traffic Management (ATM) for wider terminal areas, especially those at busy airports, which are currently not covered by the standard meteorological services stipulated by ICAO. ICAO and WMO are coordinating MSTA developments in advance of a projected endorsement in 2014.

1.2 In WMO, the idea is to develop and promote prototype forecast for the wider Terminal Area, i.e. MSTA, which supports common situational awareness, improve safety, capacity, efficiency and environmental impacts. They complement rather than replace the current products. The new services are mainly used for terminals with high air traffic density, but the situation about the developing world from the perspective of enhancing aviation safety should also be taken into consideration.
2. PROGRESS

2.1 User consultation

2.1.1 As user engagement is crucial in identifying requirements, in addition to the existing Expert Team on MSTA (ET-MSTA), a new Task Team was set up by the WMO Commission for Aeronautical Meteorology (CAeM) to strengthen engagement with aviation user communities, focusing on user needs and gathering feedback on the MSTA concept (MSTA Task Team on User Needs (TT-UN)). On the ICAO side, the Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG) also established an ad hoc group to work closely with the WMO Task Team to coordinate inputs from the requirements perspective. The work programme of the ad hoc group also includes consultations with the ICAO Air Traffic Management Requirements and Performance Panel (ATMRPP).

2.1.2 Presentation of the MSTA concept has been done at various meetings of the aviation user community in the past couple of years. Positive feedback and support were received from user representatives, especially those who face critical weather in the terminal area. Summary of general feedback collected in 2010 has been presented in a paper at the ICAO ASIA/PAC MET/ATM Seminar held in January 2011 (http://www.bangkok.icao.int/Meetings/2011/METATM_Seminar/wp13.pdf).

2.1.3 During 2011, more focused discussions were made with users at various fora: the ICAO APAC MET/ATM seminar and task force meeting, French Commission for Commercial Aviation, 6th ICAO WAFSOPSG meeting, and ICAO ATMRPP meeting through the AMOFSG Ad hoc group. In general, the following approach was preferred for further consideration in developing the MSTA requirements in collaboration with the AMOFSG:

a) **Product representation - translating MET information into impacts** - Scenario based approach that includes weather elements and whether such weather elements will reach certain threshold/criteria related to impact to the users in the terminal area. The weather events of interest could be chosen based on operational constraints and known user impacts as determined between the user and the MET authority;

   — A proposed representation of MSTA, in graphical/tabular format with colour-coded categories which present the impact to ATM, is an illustration of risk matrix/decision support tool (DST). Apart from graphical/tabular format, gridded data format will facilitate integration into DSTs for arrival and departure management. Textual representation is also required by users for uplink to cockpit to enhance common situational awareness of pilots. Moreover new technologies for MET data uplink and onboard displaying are expected from the aircraft industry that will allow an enhanced onboard visualisation of MET elements with impact on operations in the terminal area;

b) **Verification** - Verification and validation of MSTA products is considered essential so that decisions are made by the users with good knowledge about the degree of uncertainty involved. For example, if the error associated with a forecast is large, then the utility of that forecast in making ATM decisions would be limited. Conversely, forecasts with proven reliability would be integral to more sound ATM decision making processes. Expressing the error of forecasts should be simple and relate to an ATM function where possible, for example:
1) A time-success diagram can be constructed based on past performance of a system to provide a “tolerance limit” defining what can be considered acceptable. Using this definition of a “hit”, the diagram can be used to determine the likely lead time or any other desired threshold of success; and

2) Decision support models can be objectively optimized based on this “achievable accuracy at the typical time horizon” information, while in the case of human decision making, the knowledge of the expected accuracy and reliability of the input data will rationalize the process, reduce stress and improve performance of the staff in question; and

c) **Probabilistic forecasts** - Use of probabilistic forecasts in risk matrices may be considered to meet user needs for quantitative inputs to DSTs. However, the development of such forecasts should take into consideration the currently achievable scientific and technological capabilities of probabilistic forecasting. Existing limitations and constraints, such as the limited predictability of convective activity, will be a key factor for development of these types of products;

d) **Performance-based approach** - MSTA could enhance MET support to ATM Concept Components (Aerodrome Operations (AO), Demand and Capacity Balancing (DCB), Traffic Synchronization (TS), Airspace User Operations (AUO), Continuous Climb Operations (COO), Continuous Descent Operations (CDO)) by contributing to improved performance of these ATM processes or as a direct contribution to safety. This could be demonstrated using a business case, e.g. fuel reduction due to decrease of holding time through improved MET support; and

e) **Standards and guidance material for MSTA** - General top level enabling clauses with agreements between MET and ATM communities could be included in Annex 3, while details of product specifications and verification methodologies should be provided in Manuals or guidance materials.

### 2.2 Development of MSTA proposals

2.2.1 Development is underway on MSTA proposals with a view to formulate guidance material for MET service, including on a) how to provide MSTA using the latest science and technologies, b) preparation of scenario-based MSTA, which correlates to impacts, in consultation with users but allows flexibility for adaptation by local authorities, c) verification and validation methodologies that are simple and easily interpreted by users, and (d) define business case for performance-based approach in consultation with users.

2.2.2 In terms of scenario-based MSTA, the preliminary proposal is that the weather events of interest could be chosen based on operational constraints (e.g., ceiling/visibility as it relates to simultaneous ILS approach for closely spaced parallel runways, operational limits of cross wind, etc.), which are closely related to the user’s operations (e.g. reduction of airport arrival rate). For such weather parameters, verification can then focus on the critical thresholds. Here the ability of the forecasting system to correctly predict the parameter in the given categories can be measured by performance indicators such as probability of detection (POD), false alarm rate (FAR) or measures of success composed of these two. Time-success diagrams can be constructed based on past performance of the system to determine the likely lead time or any other desired threshold of success.
2.2.3 Close consultation with ATM users is underway to define impacts on terminal area operations or airport capacity based on scenario-based MSTA products, with a view to perform "business case analysis" and "assessment of MSTA under performance-based concept".

2.2.4 Inputs on the MSTA proposals will continue to be provided to the AMOFSG ad hoc group for their consideration and incorporation into various papers for further discussions with ICAO groups (e.g. ATMRPP).

3. **FUTURE WORK**

3.1 In terms of a) weather scenarios and b) verification, for those weather parameters that do not have a clearly defined operational constraint/threshold/criteria (e.g. convective forecast), further work is required to collaborate with users to define the impacts and explore appropriate verification methods that would be best communicated to and understood by users.

3.2 How to incorporate the level of probability that a significant weather event coincides with a period of certain air traffic volume into a decision support process requires expertise from risk management who are familiar with risk matrices that meet user needs. The development of such probabilistic forecasts should take into consideration the capabilities, limitations and constraints of probabilistic forecasts and further guidance in this area would be developed in consultation with relevant ICAO/WMO groups.

3.3 Up to now, the ET-MSTA has presented the concept at numerous international meetings, workshops and conferences. During these events some direct general feedback was gathered but users were also encouraged to give more detailed feedback by looking in detail to the prototypes available at the MSTA web portal ([http://www.msta.weather.gov.hk/](http://www.msta.weather.gov.hk/)). The ET-MSTA and its associated TT-UN however felt that the quality of the feedback could be improved. To achieve this goal, the following actions were decided:

   a) intensive use will be made of the CAeM Expert Network, in particular those members familiar with the MSTA initiative, to perform the following actions:

      1) direct engagement with the main national/regional aviation users (including ATC, airports, airlines, pilots) to explain the MSTA prototype in detail, the future goal and dedicated questions; and

      2) feedback gathering from these users in an active and guided way. This feedback will further on be analyzed by the TT-UN & ET-MSTA in order to consolidate a preliminary set of requirements (generic, minimum, regional differences) which will be shared with the ICAO AMOFSG as input for their work in relation to the ATMRPP; and

   b) in parallel to action a), use will be made of a dedicated user group with representatives from all relevant stakeholders. This group will also be asked to give feedback on the MSTA concept and the prototypes, but will also be used for back checking the feedback analysis and to give input on validation metrics to be established.
3.4 As part of the strengthened consultation and engagement with all relevant stakeholders, the business case analysis from a performance-based approach will be pursued. The MSTA team will also coordinate the MSTA development with other global initiatives (e.g. NextGen, SESAR, and WXXM) through the enhanced expert and user networks.

* ACTION BY THE GROUP

3.1 The AMOFSG is invited to:

a) note the information contained in this paper; and

b) exchange views on the way forward to further develop the MSTA in close collaboration between ICAO and WMO.

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