WWRP CAS/CAeM Aviation Research Demonstration Project (AvRDP) Training Workshop

8 to 10 October 2018

Hong-Kong Observatory
Hong-Kong, China
ATM Requirements for Meteorology under the GANP/ASBU

AvRDP Training workshop
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WMO OMM
World Meteorological Organization
Organisation météorologique mondiale
What is the GANP?
What does ASBU mean?
Any meteorology in there?
The Global Air Navigation Plan

ICAO’s 15-year Plan Addressing Global Air Navigation

• The Global Air Navigation Plan (GANP) is a means to help achieve a global interoperable air navigation system for all users for all phases of flight, which meets agreed safety levels, provides optimum economic operations, is environmentally sustainable and meets national security requirements.

• Objective is to increase capacity and improve efficiency of the global civil aviation system whilst improving or at least maintaining safety.

• Long-term vision to ensure continuity and harmonization with ICAO, States and industry modernization programs.

• A reference for ICAO, States, manufacturers and other organizations to develop the necessary technology, standards and procedures.

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The Global Air Navigation Plan

- A rolling, 15-year strategic methodology which leverages existing technologies and anticipates future developments based on State/industry agreed operational objectives.
- Methodology based on **Block Upgrades**, organized in non-overlapping six-year time increments starting in 2013 and continuing through 2035 and beyond.
- Triannual revision cycle, with major updates every six years, One major in 2019
Refer to the target availability timelines for a group of operational improvements i.e. technologies and procedures organized into unique Modules.

This block upgrade and module-based methodology would allow Member States to only consider and adopt the Modules appropriate to their operational needs.

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Aviation System Block Upgrades (ASBU)

Key concepts in developing the draft 2019 version of the GANP:

**ASBU Block**: a six year timeframe whose starting date defines a deadline for an element to be available for implementation.

**ASBU Thread**: key feature area of the air navigation system that needs improvement in order to achieve the vision outlined in the Global ATM Operational Concept (GATMOC).

**ASBU Element**: a specific change in operations designed to improve the performance of the air navigation system under specified operational conditions.

**ASBU Module**: a group of elements from a thread that, according to the enablers’ roadmap, will be available for implementation within the defined deadline established by the ASBU Block.

**ASBU Enabler**: component (standards, procedures, training, technology, etc) required to implement an element.

=> Operational threads, Enabler threads and Network/Infrastructure threads
Aviation System Block Upgrades (ASBU)

GANP Thread modules

Operational threads

Enabler threads

Operational threads

Operational threads

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Meteorology in 2019 GANP/ASBU

From the ICAO ASBU Panel Project Team work:

- Meteorology is an Enabler for the majority of the other Threads.
- Challenge is to ensure that all the other ASBU threads and related modules are able to fully articulate the requirements they have for MET information in the future.
- This means looking at the MET information required, rather than existing products.
- Information includes phenomenon/parameter and data characteristics such as severity, accumulation, intensity, probability of occurrence, confidence/uncertainty of forecasts and reliability, etc.
- Evolution of AMET thread and modules is driven by the transition to the SWIM environment and by the need for more interoperability allowing integration of MET information in ATM systems.
AMET Block 0:
Global, regional and local meteorological information to support flexible airspace management, improved situational awareness, collaborative decision-making and dynamically optimized flight trajectory planning.

AMET Block 1:
Meteorological information supporting automated decision process or aids, involving meteorological information, meteorological information translation, ATM impact conversion and ATM decision support.

(from 2013) (from 2019)
AMET Block 2:
Integrated meteorological information in support of enhanced operational ground and air decision-making processes, particularly in the planning phase and near-term.

AMET Block 3:
Integrated meteorological information in support of enhanced operational ground and air decision-making processes, for all flight phases and corresponding air traffic management operations.

AMET Block 4:
Integrated meteorological information supporting both air and ground decision making for all phases of flight and ATM operation, especially for implementing immediate weather mitigation strategies.
### AMET – METEOROLOGICAL INFORMATION

**CONCEPT OF OPERATIONS OF THE THREAD BY BLOCK**

<table>
<thead>
<tr>
<th>Block</th>
<th>Element ID</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block 0</td>
<td>AMET-B0/1</td>
<td>Meteorological observations products</td>
</tr>
<tr>
<td>Block 0</td>
<td>AMET-B0/2</td>
<td>Meteorological forecast and warning products</td>
</tr>
<tr>
<td>Block 0</td>
<td>AMET-B0/3</td>
<td>Climatological and historical meteorological products</td>
</tr>
<tr>
<td>Block 0</td>
<td>AMET-B0/4</td>
<td>Dissemination of meteorological products</td>
</tr>
<tr>
<td>Block 1</td>
<td>AMET-B1/1</td>
<td>Meteorological observations information</td>
</tr>
<tr>
<td>Block 1</td>
<td>AMET-B1/2</td>
<td>Meteorological forecast and warning information</td>
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<td>AMET-B1/3</td>
<td>Climatological and historical meteorological information</td>
</tr>
<tr>
<td>Block 1</td>
<td>AMET-B1/4</td>
<td>Dissemination of meteorological information</td>
</tr>
<tr>
<td>Block 2</td>
<td>AMET-B2/1</td>
<td>Meteorological observations information</td>
</tr>
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<tr>
<td>Block 3</td>
<td>AMET-B3/1</td>
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</tr>
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<td>AMET-B3/4</td>
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<td>Block 4</td>
<td>AMET-B4/1</td>
<td>Meteorological observations information</td>
</tr>
<tr>
<td>Block 4</td>
<td>AMET-B4/2</td>
<td>Meteorological forecast and warning information</td>
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<tr>
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<td>AMET-B4/3</td>
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<tr>
<td>Block 4</td>
<td>AMET-B4/4</td>
<td>Meteorological information service in SWIM</td>
</tr>
</tbody>
</table>

### Meteorology in 2019

GANP/ASBU
**METEOROLOGICAL FORECAST AND WARNING INFORMATION**

**Main purpose**
Meteorological forecast and warning information in support of automated decision processes or aids and performance based requirements, involving meteorological information, meteorological information translation, ATM impact conversion and ATM support decision.

**New capabilities**
Commencement of change from product-centric to data-centric information. Commencement of space weather and sulphur dioxide (SO2) services. Enhanced hazardous weather services. First steps in the provision of probabilistic information derived from ensemble prediction systems.

Meteorological forecasts and warnings will begin to transition from traditional alphanumeric code (TAC) format to data-centric information to better support the common understanding on the various operational constraints, capabilities and use of Information SWM compliant forecast and information products. The following will be made available to users and will include:
- Wind speed and direction (aerodrome) including gusts and operationally significant wind shifts
- Air temperature and dew point temperature (aerodrome)
- Upper level
  - Wind (speed and direction), including departure to Top of Climb (TOC) and then Top of Descent (TOD) to landing
  - Air temperature and dew point temperature or equivalent (e.g., humidity), including height of freezing level and lower tropospheric temperature inversions
- Flight level and temperature of tropopause
- Geopotential altitude for flight levels
- Pressure (aerodrome) (e.g., QNH, QFE)
- Visibility (aerodrome), Runway visual range (RVR)
- Cloud type of operational significance
- Cloud coverage, bases, tops and layers
- Thunderstorms, Lightning, Convection (TCU & CB)
- Precipitation (e.g., drizzle, rain, freezing rain, snow, hail)
- Weather (e.g., dust storm, sand storm, funnel cloud, squall, smoke, haze, mist, fog)
- Icing (airframe and engine)
- Liquid Water Content, Iced Water Content
- Turbulence, Mountain waves, Wind shear
- Fronts
- Radioactive clouds, Toxic chemicals
- Tropical cyclones
- Volcanic ash
- Sulphur dioxide (SO2) and other hazardous gases
- Sea temperature, state and wave height (seaport)
- Space weather events
- Tsunami

**Characteristics of the meteorological information include:**
- Time (e.g., issue time, validity, commencement/cessation, lead time)
- Units of measurement
- Resolution (temporal & spatial)
- Geo Location (2D/3D/4D context, point, line or polyhedron)
- Movement
- Severity, Accumulation, Intensity
- Range (Max – Min.)
- Variations
- Probability of occurrence
- Confidence/Uncertainty of forecast
- Reliability
- Data sample period
- Auto
- Change indicator period
- Amendment/Correction
- Operational Status
- Source

**的竞争性**

- Thresholds
- Formats (TAC, Gridded, Graphical, IWXXM)
- Data quality flag
- Runway identification or location identifier
- Effects/Impact on aviation systems (i.e., communications, navigation & surveillance systems)
- Radiation (exposure)

Human-readable meteorological advisory and warning products start to be derived from the meteorological information data to better suit user needs and can be based on user-defined thresholds. Meteorological information to be used to assess impact.

Verification of quality (accuracy) of forecast parameters. An increased use performance measures (via compliance, availability and suit-regularity indices) of forecast parameters.

**Human Factors**
- Change in task planner? Yes
- Processing of new information by user? Yes
- Use of new equipment? Yes
- Change in level of automation? Yes

**Dependencies and relations**
- Evolution
- Relation
- ID
- Title
- ASBU element
- AMET-80/2
- AMET-81/1

**Operations**
- Flight phases
- Turn-around
- Taxi-out
- Departure
- En-route
- Amural
- Taxi-in

**Planning layers**
- ATM planning
- Strategic
- Pre-tactical
- Tactical
- Pre ops
- During ops
- Post operations

**Enablers**
- Category
- Type
- Description/Examples
- Stakeholder(s)

**Operational Procedures**
- Manual
- Guidance
- Handbook
- Document

**Part 1**

**Part 2**

**Part 3**

**Part 4**

**Enablers**

**Operational Procedures**

**Annex**

Annex 3 - Meteorological Service for International Air Navigation

**WMO No. 45 Vol II - Technical Regulations - Basic Documents No. 1, Volume II - Meteorological Service for International Air Navigation**

**WMO No. 45 Vol IV - Technical Regulations - Basic Documents No. 2, Volume IV - Quality Management**

**PANS**

PANS Procedures for Air Navigation Services – Meteorology (PANS-MET) – being developed

**PANS**

Doc. 4444 - Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM)

**Manual**

WMO No. 305 - Manual on Codes – International Codes

WMO No. 732 - Guide to Practices for Meteorological Offices Serving Aviation

WMO No. 782 - Aerodrome Reports and Forecasts


WMO No. 1100 - Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services

Doc. 7488 - Manual of the ICAO Standard Atmosphere

Doc. 8896 - Manual of Aeronautical Meteorological Practice

Doc. 9691 - Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds

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SWIM and IWXXM ... necessary to allow interoperability and integration of MET information into ATM systems

IWXXM = model; built on XML schemes defined by WMO CBS TT-AvXML
Terminals area

WMO OMM

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...this module acknowledges the need to provide meteorological information services with the **accuracy, resolution and frequency** to support ATM operations within those areas.
Meteorology in 2019 GANP/ASBU

From the ICAO ASBU Panel Project Team work:

- Meteorology is an **Enabler** for the majority of the other Threads.

Dependencies between threads and/or elements:

- *what relations AMET has with other threads,*
- *what are the elements in other threads the AMET modules depend on,* and
- *what are the AMET elements that modules in other threads depend on.*
<table>
<thead>
<tr>
<th>AMET-81/4</th>
<th>DISSEMINATION OF METEOROLOGICAL INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main purpose</strong></td>
<td>Dissemination of meteorological information in support of automated decision process or aids, involving meteorological information, meteorological information translation, ATM impact conversion and ATM decision support.</td>
</tr>
<tr>
<td><strong>New capabilities</strong></td>
<td>Meteorological information in ICAO Meteorological Information Exchange Model (IWXXM) form starts to replace traditional alphanumeric code (TAC) products. Human-readable products will start to be derived from the IWXXM information (rather than the other way around). The introduction of web services allows for progressive replacement of fixed line dissemination systems.</td>
</tr>
</tbody>
</table>

**Dissemination**
- This element represents the dissemination of meteorological products using a variety of formats, including:
  - Tailored products (human-readable)
  - ISO 7816-8 products
  - Graphical (FNG and BUFR to be phased out)
  - ICAO Meteorological Information Exchange Model (IWXXM) format
  - Traditional alphanumeric code (TAC) — being phased out

Dissemination means include aeronautical fixed service (i.e., AMHS) and via secure internet services (i.e., WIFS/SADIS). Commencement of SWIM-compliant web service capability to access the exact meteorological information required by users (in terms of geographical coverage, resolution, etc.).

**Human Factors**
- Change in task by user? Yes
- Processing of new information by user? Yes
- Use of new equipment? Yes
- Change in level of automation? Yes

**Dependencies and relations**

<table>
<thead>
<tr>
<th>Type of dependencies</th>
<th>Evolution</th>
<th>Relation</th>
<th>ID</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMET-81/1</td>
<td>X</td>
<td>AMET-81/1</td>
<td>MET</td>
<td>Meteorological observations information (operational requirement)</td>
</tr>
<tr>
<td>AMET-81/2</td>
<td>X</td>
<td>AMET-81/2</td>
<td>MET</td>
<td>Meteorological observations information exchange (operational requirement)</td>
</tr>
<tr>
<td>COMS-81/1</td>
<td>X</td>
<td>COMS-81/1</td>
<td>PBS</td>
<td>Bureau of Meteorology (MFA) for domestic and procedural airspace</td>
</tr>
<tr>
<td>COMS-81/2</td>
<td>X</td>
<td>COMS-81/2</td>
<td>PBS</td>
<td>Bureau of Meteorology (MFA) for procedural airspace</td>
</tr>
<tr>
<td>COMS-81/3</td>
<td>X</td>
<td>COMS-81/3</td>
<td>SAT</td>
<td>SATVOICE (incl. routine communications) for procedural airspace</td>
</tr>
<tr>
<td>COMI-81/1</td>
<td>X</td>
<td>COMI-81/1</td>
<td>VHF</td>
<td>VHF Data Link (VDL) Mode 2 Multi-Frequency</td>
</tr>
<tr>
<td>COMI-81/2</td>
<td>X</td>
<td>COMI-81/2</td>
<td>SBC</td>
<td>SATCOM Class B (SB-S) Voice and Data</td>
</tr>
<tr>
<td>COMI-81/3</td>
<td>X</td>
<td>COMI-81/3</td>
<td>COM</td>
<td>Commercial links for non-safety critical</td>
</tr>
<tr>
<td>DAIM-81/1</td>
<td>X</td>
<td>DAIM-81/1</td>
<td>DAI</td>
<td>Provision of quality assured aeronautical data and information</td>
</tr>
<tr>
<td>DAIM-81/2</td>
<td>X</td>
<td>DAIM-81/2</td>
<td>DAI</td>
<td>Provision of digital Aeronautical Information Publication (AIR) data sets</td>
</tr>
</tbody>
</table>

**Operations**
- **Flight phases**
  - Taxi-out
  - Departure
  - Arrival
  - Taxi-in
  - Turn-around

**Planning layers**
- ATM planning
- Strategic
- Pre-tactical
- Tactical
- During ops
- Post operations

**Enablers**
- **Category**
  - Annex
  - Technical Regulation

**Regulatory Provisions**
- Annex 1 - Meteorological Service for International Air Navigation
- WMO No. 49 Vol III - Technical Regulations Basic Documents No. 2, Volume II - Meteorological Service for
Example of dependency of one ATM element on AMET

ACDM-B1/1 – Airport CDM – Airport Operations Plan

Main purpose:
To fully integrate airports in the ATM network and enhance collaboration between airports stakeholders.

New Capabilities:
Airport stakeholders will be able to better communicate and coordinate among themselves to develop and maintain dynamically joint plans and to execute those in their respective area of responsibility.

Dependencies on AMET (type= Relation-Information need)

AMET-B1/1 - Meteorological observations information
AMET-B1/2 - Meteorological forecast and warning information
AMET-B1/4 - Dissemination of meteorological information
ICAO GANP web portal

https://www4.icao.int/ganppportal/

- Where to find the most relevant information related to the GANP;
- It provides elements and threads overview including AMET elements:
  https://www4.icao.int/ganppportal/ASBU
- And a graphics of dependencies.

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ICAO GANP/ASBU more information

Also presented at WMO Aeronautical Meteorology Scientific Conference, in Toulouse, France in November 2017:


Thank you
Merci