Aeronautical Information Exchange Model (AIXM) – Lessons learned

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About EUROCONTROL - European Organisation for the Safety of Air Navigation
Europe – air traffic at a glance

450 Important Airports

+-1500 Aircraft Operators

Peaks + 34,400 Flights a day

+ 10,000,000 Flights a year
EUROCONTROL – European Organisation for the Safety of Air Navigation

40 member states & the European Community

>50 years!
>2000 people
Complementary Partners

- Political direction
- Community method
- Regulatory authority
- Finance

- Technical expertise
- Facilitation skills
- Civil-military

“Technical Agency of the Single European Sky”
You typically hear about us when things go wrong…
About AIXM
AIXM – why necessary

- European Aeronautical Information Services Database (EAD) Feasibility Study (by “CAPdebis”) - 1993
  - “The exchange of static data in an electronic format is rare for ground based systems. Other than ARINC 424 format, which was developed according to the demands of FMS, a state of the art, commonly used standard format for the exchange of static data information […] is not available.”

- Need for aeronautical information logical model + data exchange format
  - For the implementation of the European AIS Database (EAD)
  - Basis for “electronic AIP”
  - Proposal for global standard (International Civil Aviation Organisation)
  - For industry implementations
  - etc.
AIXM Scope

Air Transportation Information

- Airspace structures and routes
- Ground Infrastructure
- Rules and procedures
- Passenger
- MET
- Terrain and obstacles
- Flight
- Surveillance
AIXM 4.5: two main components

AIXM – Logical Information Model

AIXM – Data Exchange Format
AIXM in EAD (today)

- Static data update
  - (SDO) Based on AIXM 4.5

- Digital Data Input (AIXM 4.5 XML)

- AIXM 4.5 / 5.1 XML output

- Chart Production

- (e)AIP Production

- Support NOTAM production

Provided by industry.
Similar implementation in local AIS systems
AIXM version 5 – key aspects
AIXM version 5

Joint development EUROCONTROL – FAA
(with the support of the international AIS community)
AIXM 5 Design Objectives

New capabilities

- Modularity
- Extensibility
- Flexible Exchange
- Flexible Messages
- Static and Dynamic

Technical Design Decisions

- ISO19100 series
- UML
- GML 3.2

Expand/Refresh Domain Model

- Aerodrome Mapping
- Terminal Procedures
- Obstacles

External Constraints

- Metadata
- Integrity
AIXM version 5.1
Temporality Model

- **Definition**
  - A model that incorporates the concept of time at feature level!

- **Key assertions**
  - All features are temporal with start of life and end of life
    - Example - a new air traffic control sector
  - All features can change over time
    - Example - a navigation aid changes frequency
  - Additional issue – feature properties can have different values according to a repetitive schedule

- **AIXM Temporality Model**
  - Relates feature properties to the time extent in which they are valid
  - Provides various means to describe the time extent
The basic Time Slice model
Temporary events (digital NOTAM)
Many years ago…

- **NOTAM = N**otice **T**o **A**ir**M**en

- When not more than 10-20 NOTAM were on the list for one flight 😊

- With 25000 NOTAM in force world-wide at every moment 😞
  - only digital data processing can help…
Digital NOTAM = visual NOTAM
Enhanced Pre-flight Information Bulletin (mockup)

**Departure Aerodrome: UKBB**

**METAR:**

UKBB 211455Z 13609KT 080V160 9999 BKN800 20/12
01015 CATOK NSW

**TAF:**

UKBB 211455Z/0915/1016 10012G21KT 8000 OVC007
TEMPO 0915/0917 1000 SHSN BR BKN003 SCT008CB
BECMG 0917/0919 10016G25KT 4000-SN BLSN OVC005
TEMPO 0919/10160000 5SHSN BLSN OVC003 BKN008CB
BECMG 1006/100814014G23KT TTM004/1032 TXM009/10122

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**AFR1953 — 09 May 2011 15:15 UTC — UKBB-LFPG**
AIXM 5 - Use of Geography Markup Language (GML)

AIXM 4.5 – non GML

AIXM 5.1 – GML
GML-based tools for AIXM data visualisation
Guidance and Profile of GML for use with Aviation Data

- Published: MAY 2012 by OGC (produced by the Aviation Domain WG)
- 1st part - Encoding guidelines for aviation specific data
  - srsName (WGS 84 is imposed in aviation)
  - Surface and lines - specials
  - Parallels
  - Arcs
  - Embedded curves/points
  - Geographical borders re-used in Surface definitions
    - In relation with the use of AIXM for aeronautical data encoding
- 2nd part - GML Profile
AIXM 5.1 extensions

Core AIXM
Aeronautical information that is relevant for the whole ATM community world-wide, not regional specific (AIP, NOTAM, etc.)

Additional information exchanged between selected partners
Extensions – UML model

```
<<extension>>
Airspace
flexibleUse : CodeYesNoType
level1 : CodeYesNoType
level2 : CodeYesNoType
level3 : CodeYesNoType

<<feature>>
Unit
(responsibleAMC : 0..1
+responsibleAMC
isUnderResponsibilityOf
+requestor
isActive
+activation
+hostAirspace
isLocatedIn

<<object>>
AirspaceActivation
(reservationPhase : 0..*
+activation
from Airspace)

<<extension>>
AirspaceActivation
isRequestedBy
+requestor
0..1

<<object>>
Airspace
(isActive : isActive
+activation
from Airspace)

<<feature>>
Unit
from Organisation

<<object>>
PropertiesWithSchedule
(from Schedules)

<<extension>>
Airspace
(isActive : isActive
+activation
from Airspace)

<<object>>
MilitaryActivity
(militaryActivity : militaryActivity
+responsibleAMC
0..1
+requestor
0..*

<<extension>>
Airspace
(reservationPhase : reservationPhase
+activation
0..*
from Airspace)
```

```
AirspaceManagementCell : CodeYesNoType
```

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**Related diagrams:**
- [Diagram 1](#)
- [Diagram 2](#)
Extensions – feature/object

Purpose

• data of local interest
• forward compatibility
Validation of AIXM data sets

- Syntactic check
  - Check the compliance of an XML dataset with the XSD grammar
  - Performed by standard XML parsers (e.g. xerxes, MSXML, XMLSpy, etc.)

- Semantic check
  - Does the data make sense?
  - Is it compliant with international standards?
  - Do I respect recommended practices?
  - ...

- Business Rules
  - AIXM 5.1
  - UML
  - AIXM 5.1
  - XSD

- PropertiesWithSchedule (from Schedules)
  - ContactInformation
    - name: TextNameType
    - title: TextNameType
  - ContactInstruction
  - FlightRestrictionRoute
    - priorPermission: CodeYesNoType
  - FlightRestriction
    - designator: CodeFlightRestrictionDesignatorType
    - type: CodeFlightRestrictionType
    - instruction: TextInstructionType
  - FlightRoutingElement
    - orderNumber: NoSequenceType
    - speed: ValSpeedType
    - speedReference: CodeSpeedReferenceType
    - speedCriteria: CodeComparisonType
  - FlightConditionCombination
    - logicalOperator: CodeFlowConditionOperationType
  - FlightConditionCircumstance
    - FlightRestrictionLevel
      - flightLevel
        - flightLevel
          - isRestrictedTo: FlightConditionElement
            - index: NoSequenceType
            - element
              - hasOperand
                - 0..1
                - operationalCondition
                  - hasCondition
                    - 0..1
                    - hasCondition
                      - 0..*
                      - isApplicableAt: FlightConditionElementChoice
                        - 1
                        - 0
                        - flightCondition
                          - is
  - FlightConditionElementChoice
    - 1
    - 0
    - flightCondition
      - is
Use of SBVR

- **SBVR = (OMG) Semantics of Business Vocabulary and Business Rules**
  - defines the vocabulary and rules for documenting the semantics of business vocabularies, business facts, and business rules.

- It identifies two types of business rules
  - **Structural rules**
  - **Operative rules**

- AIXM 5 has adopted this terminology and identifies the following business rules:
  - **AIXM Structural rules**: the enumerations of values (datatypes)
    - (Most) coded already in the AIXM schema
  - **AIXM Operative rules**: rules extracted from official documents (ICAO Annexes), minimum data rules, consistency rules, recommended practices, coding rules...
SBVR in AIXM - example

- ICAO Annex 11: “If a control zone is located within the lateral limits of a control area, it shall extend upwards from the surface of the earth to at least the lower limit of the control area.”
- SBVR equivalent:
Encoding Business Rules
ISO Schematron

- **Schematron** ([http://www.schematron.com/](http://www.schematron.com/))
  - is an open language for the validation of XML documents...
  - ...whose specification is standardized (ISO/IEC 19757)

- There are 6 basic elements in ISO Schematron: assertion, rule, pattern, schema, namespace and phase.
SESAR – System Wide Information Management
SWIM context

**SWIM consists of standards, infrastructure and governance enabling the management of ATM information and its exchange between qualified parties via interoperable services.**

![SWIM Context Diagram]

**SWIM Governance**

- **Qualified parties**
  - ATM information
  - Service consumer(s)

- **Qualified party**
  - ATM information
  - Service(s)

**SWIM Infrastructure**

- Network infrastructure (Internet, PENS)

**Standards**

- Standards
- Standards
- Standards
We are making powerful information from operational data.

Global AIRM

AIXM

WXXM

FIXM

Other ATM data
Building on the success of last year's edition, the second SWIM Master Class is planned from June to November 2013.

This year, more ATM data providers are entering the game, offering development teams a wider scope of data and services to exploit in their SWIM-enabled applications or web-services.

Therefore ATM data service providers and developers are invited to participate to the launch of an even more promising challenge.

**5 key steps to know about**

- Expression of interest by ATM data providers and development teams: April - May 2013;
- Selection of ATM data providers covering one or more ATM domains: April - May 2013;
- SWIM Initiation Day/Kick-off: June 2013. An opportunity to enhance your knowledge of SWIM and acquire more information about the SWIM Master Class Platform/Infrastructure/ATM Data Providers;
- Open competition: July to October 2013. Time for creative business and development teams to demonstrate their ability to develop new applications or web services based on SWIM technologies;
- SWIM best-in-class ceremony: November 2013 at EUROCONTROL Headquarters awarding the winners and demonstrating the best prototypes.

**Enter the growing SWIM community**

“For us, one of the most valuable parts of the Master Class for promoting and furthering SWIM has been in sharing our prototype and findings with the other Master Class participants” (Ian Fairley, Managing Director at Snowflake).

Over 100 participants took part to the first SWIM Master Class in 2012, acquiring state-of-the-art expertise and sharing experience amongst top-notch SWIM experts. The Best-in-Class ceremony awarded the prototypes from Snowflake Software, M-Click and Thales Air Systems.

The SWIM Master Class is open on a voluntary basis to all interested parties wishing to demonstrate their SWIM-enabled application built on selected data service providers.

The best-in-class developments will be given the opportunity to demonstrate their results during the awards ceremony in November 2013.

Are you ready to take on the challenge and share experience, raise your profile within the ATM community and create new business opportunities?

Contact us at swim@eurocontrol.int and register before 30 April 2013.
Conclusions

- AIXM version 5 - key aspects
  - UML model
  - Temporality concept
  - Use of GML/XML Schema
  - Extensibility
  - Status and condition of aeronautical features (digital NOTAM)
  - Business Rules

- We are interested in further cooperation
  - GML?
  - SWIM Master Class?
Contact Information

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