AFI Region AIXM e-AIP Implementation Workshop Dakar, Senegal, 3-5 October 2016

AIXM Purpose, Scope, Implementation and Future Evolution

Razvan GULEAC
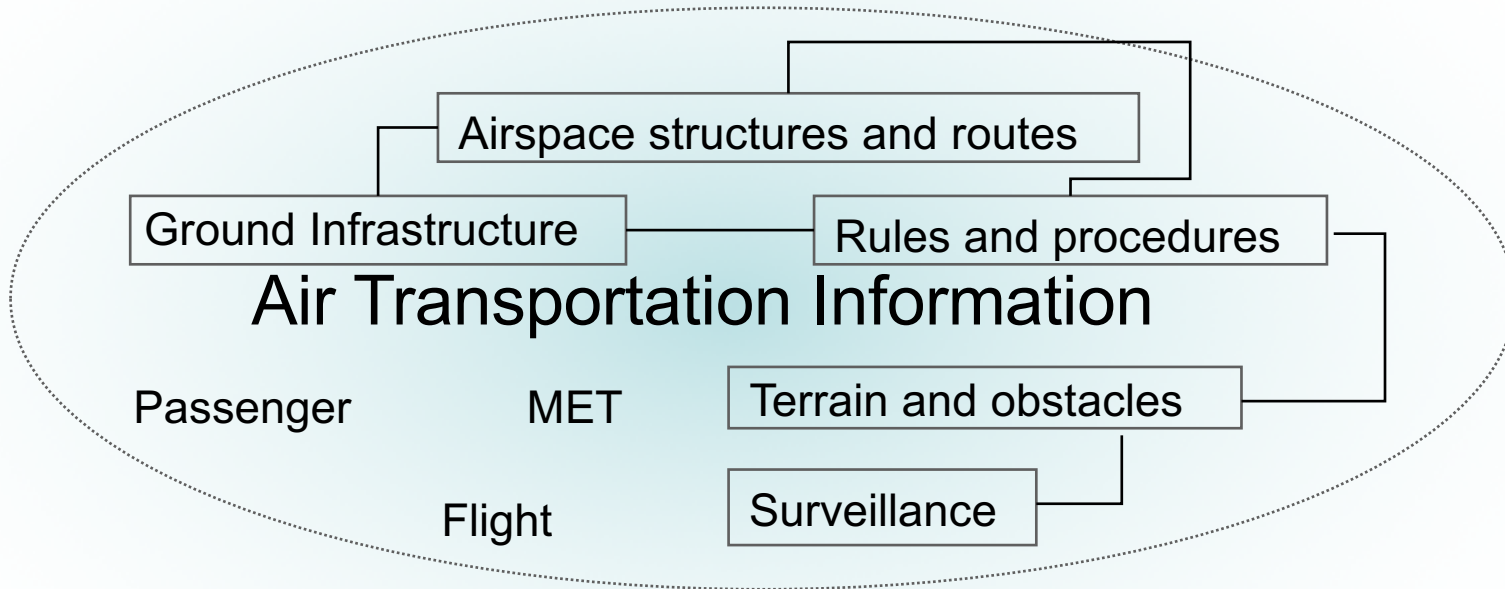EUROCONTROL

Why AIXM?

- 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."*
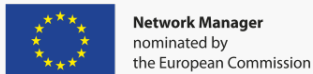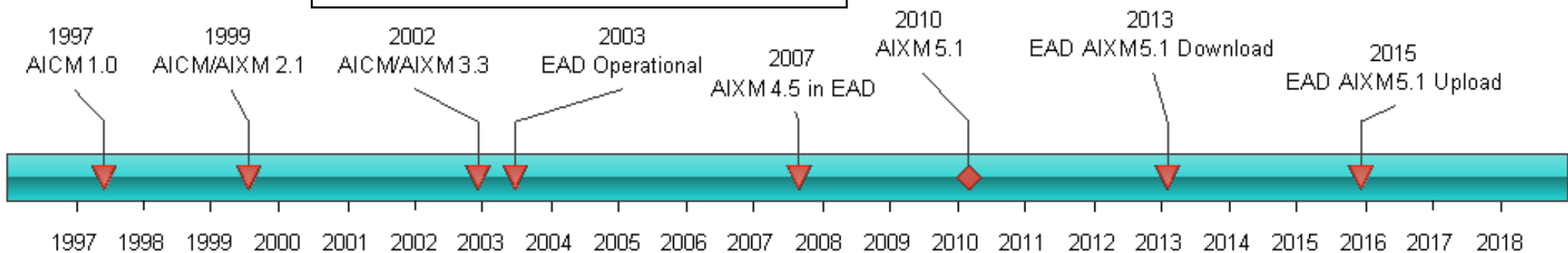
- Need for aeronautical information logical model + data exchange format
    - For the implementation of the European AIS Database (EAD)
    - Basis for eAIP
    - Contribution to ICAO (AIS/MAP Divisional Meeting of 1998)
    - For industry implementations
    - etc.
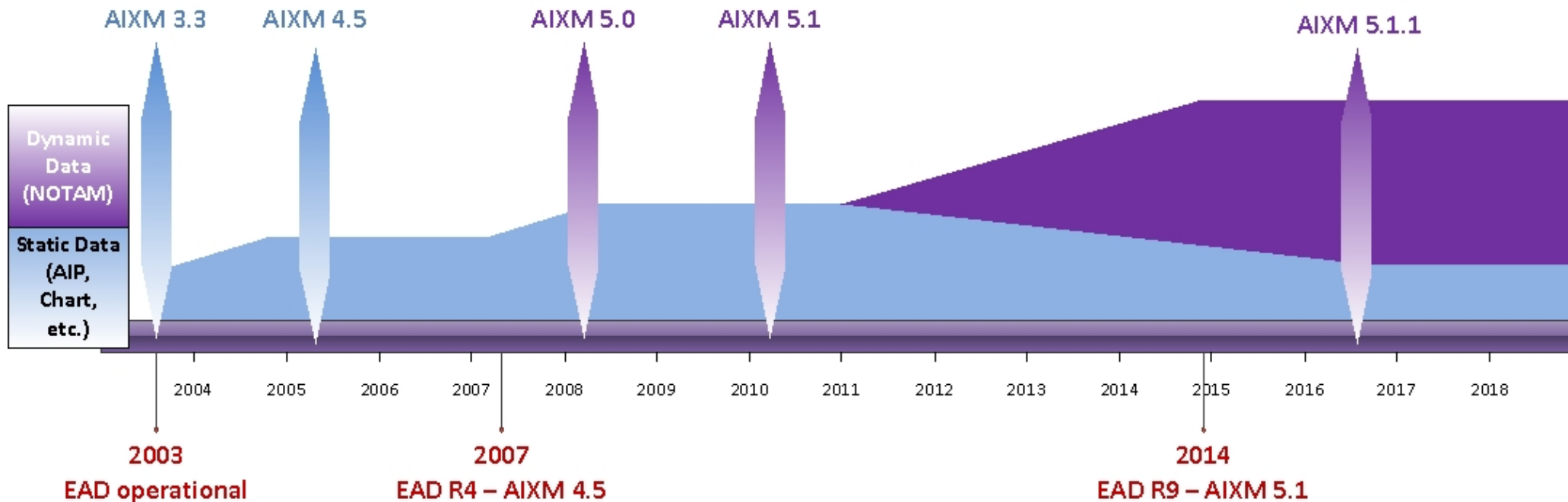
Why AIXM?

Air Transportation Information

- Airspace structures and routes
- Ground Infrastructure
- Rules and procedures
- Passenger
- MET
- Terrain and obstacles
- Flight
- Surveillance

Network Manager
nominated by
the European Commission

AIXM Development in Europe

AIP

1997
AICM 1.0

1999
AICM/AIXM 2.1

2002
AICM/AIXM 3.3

2003
EAD Operational

2007
AIXM 4.5 in EAD

2010
AIXM 5.1

2013
EAD AIXM5.1 Download

2015
EAD AIXM5.1 Upload

1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Network Manager
nominated by
the European Commission

AIXM Purpose, Scope, Implementation and Future Evolution

AIXM version 5

Joint development EUROCONTROL – FAA
(with the support of the international AIS community)

AIXM 3.3 AIXM 4.5 AIXM 5.0 AIXM 5.1 AIXM 5.1.1

Dynamic Data (NOTAM)

Static Data (AIP, Chart, etc.)

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

2003
EAD operational

2007
EAD R4 – AIXM 4.5

2014
EAD R9 – AIXM 5.1

Network Manager
nominated by
the European Commission

AIXM Purpose, Scope, Implementation and Future Evolution

AIXM 5 Design Objectives

New capabilities

Modularity

Extensibility

Flexible Exchange

Flexible Messages

Static and Dynamic

+

Technical Design Decisions

ISO19100 series

UML

GML 3.2

+

+
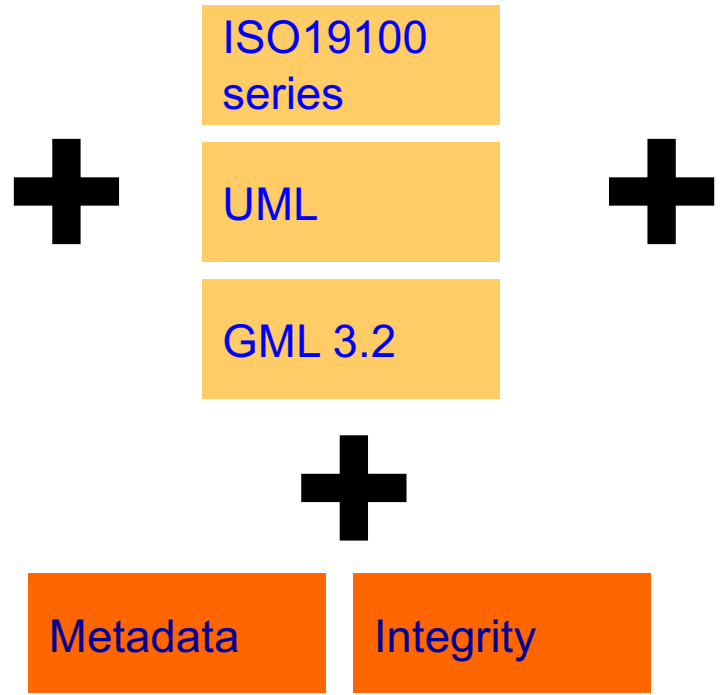
Expand/Refresh Domain Model

Aerodrome Mapping

Terminal Procedures

Obstacles

Metadata	Integrity

External Constraints
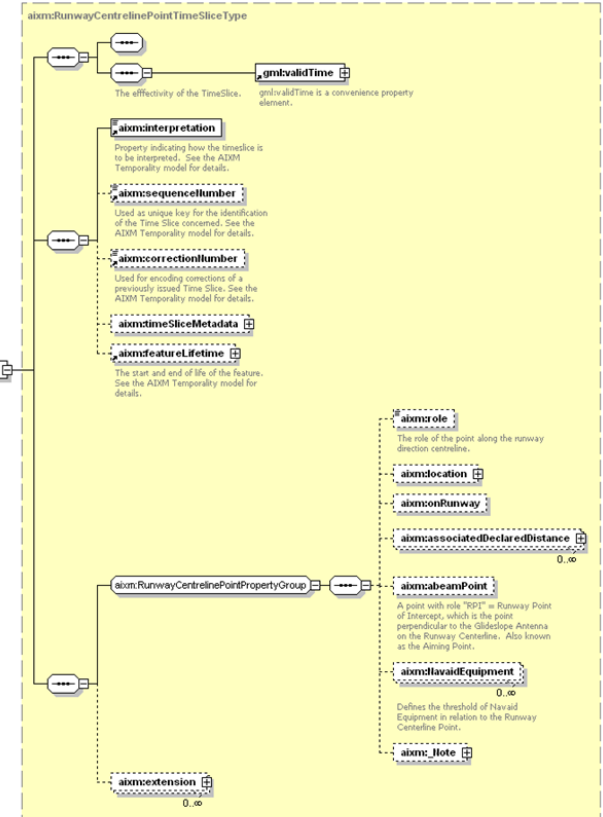
Network Manager
nominated by
the European Commission

AIXM 5 Design Objectives

UML

XSD

Feature Properties

Temporality Concept

www.aixm.aero
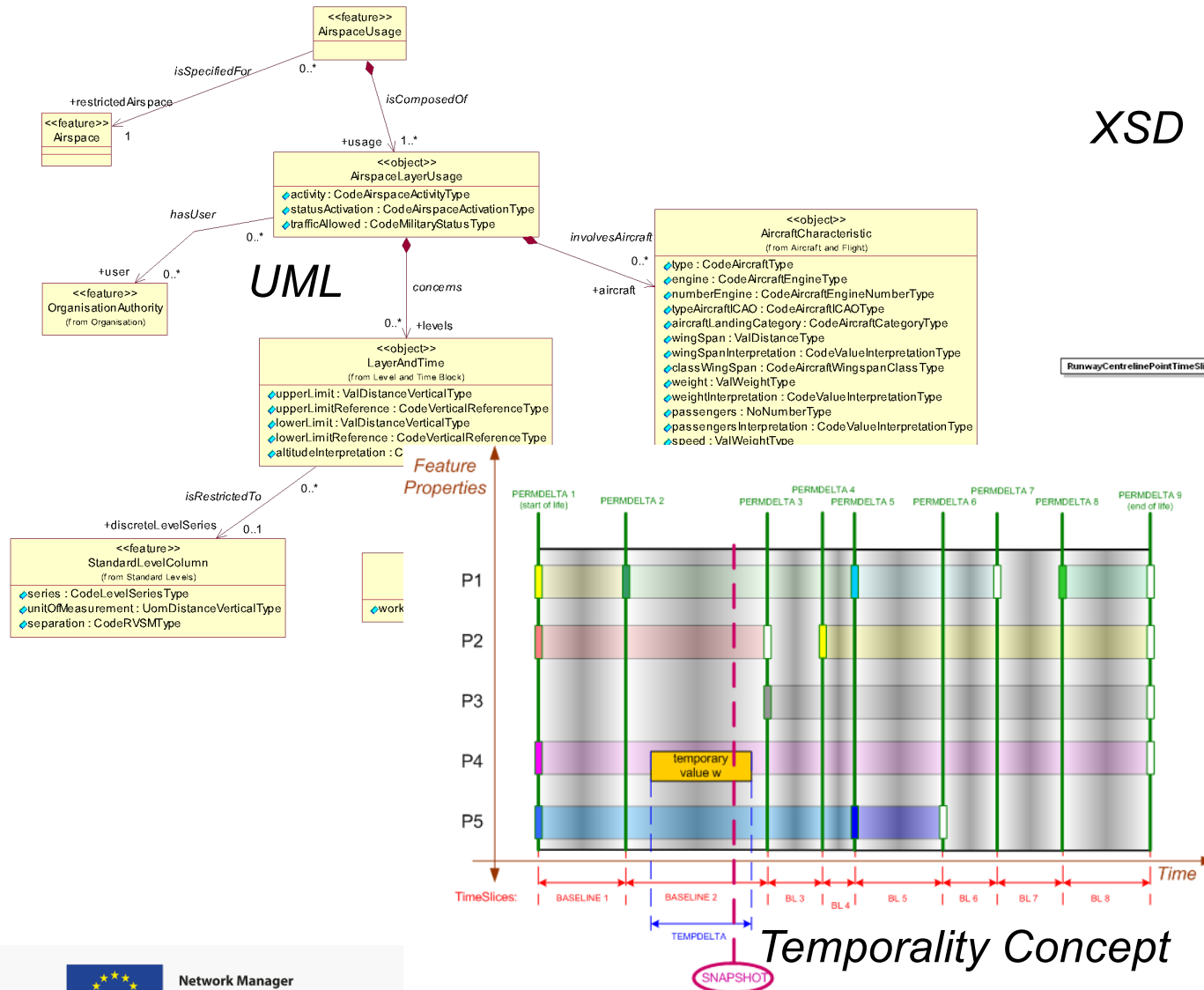
AIXM 5.1 – Digital NOTAM capability

TWY closure

- Currently, published as NOTAM

> A0874/03 NOTAMN
> Q) EBBU/QMXLC/IV/M/A/000/999/5054N00429E005
> A) EBBR
> B) 0308250500 C) 0310271600   <OK for computers>
> E) TAXIWAYS OUTER 7 AND E6 CLSD   <not OK for computers>

- With Digital NOTAM - AIXM 5.1 encoded message

  - Something like this …

    ```
    <taxiway>
     <name>OUTER 7</name>
     <status>CLOSED</status>
    </taxiway>
    <taxiway>
     <name>E6</name>
     <status>CLOSED</status>
    </taxiway>
    ```

AIXM Temporality document

EUROCONTROL

AIXM 5 | Version 5.0 Date:11/15/2007 | Temporality Proposal

1. The need for a temporality model

Time is an essential aspect on the aeronautical information world, where change notifications are usually made well in advance of their effective dates. Aeronautical information systems are requested to store and to provide both the current situation and the future changes. The expired information needs to be archived for legal investigation purposes.

For operational[1] reasons, a distinction is usually made between:

- *permanent changes* (the effect of which will last until the next permanent change or until the end of the lifetime of the feature) and
- *temporary status* (changes of a limited duration that are considered to be overlaid on the permanent state of the feature).

A temporary change includes the concepts of overlay and reversion. The temporary change is overlaid on the permanent feature state. When the temporary change ends, the temporary changes no longer apply and we revert back to the permanent feature state.

Note that, from an operational point of view, "temporary status" also includes the concept of "temporary features". However, from the AIXM point of view, temporary features are in no way different from normal features. The feature is created and withdrawn, just that the life span is shorter than usual.

In order to satisfy the temporal requirements of aeronautical information systems, AIXM must include an exhaustive temporality model, which enables a precise representation of the states and events of aeronautical features. In particular, this shall enable the development and the implementation of digital NOTAM. By digital NOTAM we mean replacing the free text contained in a NOTAM message with structured facts, which enable the automated processing of the information.

A general temporal model should be uniformly applied to all aeronautical feature types and the temporality concept should be abstracted from the task of modeling object properties. At the conceptual level, the model should describe the temporal evolution of the features, as they occur in the real world. This shall be done in compliance with the following rules:

- Completeness - all temporal states must be representable;
- Minimalism - use of minimal number of elements;
- Consistency - no reuse of elements with different meaning;
- Context-free - meaning of (atomic) elements independent of context; no functional dependency of (atomic) elements at the data encoding level;

The data exchange specification shall support the conceptual model. In addition, convenience elements ("views") may be introduced in the data exchange specification in order to facilitate the operations. This means that the data exchange specification may deviate from the "minimalism" rule.

[1] For example, systems that produce printed aeronautical documentation (AIP, charts) tend to ignore temporary status information; only the static data is represented on such printed products.

Page 4 of 28

AIXM 5 | Version 5.0 Date:11/15/2007 | Temporality Proposal

2. Building the Temporality Model

2.1 (step 1) Time varying properties

There are two levels at which aeronautical feature instances are affected by time:

- Every feature has a start of life and an end of life;
- The properties of a feature can change within the lifetime of the feature; this includes the possibility for a property to not be defined over a time period.

The start of life and the end of life may also be considered as feature properties (attributes). This gives the following high-level list of properties for any AIXM feature:

- a global unique identifier;
- the start of life (date and time);
- the end of life (date and time);
- attributes and associations that qualify, quantify or relate in some form that feature.

It is considered that any feature property may change in time, except for the global unique identifier. This is a key assumption of the AIXM Temporality model.

The first step in the construction of the AIXM temporality model is represented by the diagram below, which shows the values of a feature's properties (P1, P2, … P5) along a timeline.
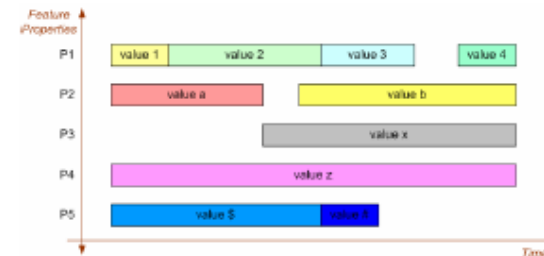
Figure 1

Discussion: *Can the start of life and the end of life properties of a feature vary in time?*

At first sight, probably not. A feature is created at a moment in time and will cease to exist at another moment in time. But this is true only when considering the already known history of a feature. When exchanging data about the future, there might be situations where the start/end of life is planned to happen at a certain date/time and this date might change.

Therefore, we have to include the start/end of life of a feature in the time varying properties list.

Page 5 of 28

---

www.aixm.aero

AIXM Purpose, Scope, Implementation and Future Evolution

AIXM 5.1
Aeronautical Information Exchange Model

EXPORT ▼   MORE ACTIONS ▼   ◻ ANNOTATE

AIXM Wiki - Home

Last modified by **EDUARD POROSNICU** on 2016/08/15 15:25   **Comments** (0) · **Attachments** (6) · **History** · **Information**

What is available

- **AIXM** documentation and related specifications
  - (*Please use the new "**UML navigator for AIXM 5.1 and AIXM 5.1.1**" available on the main Web site, as this will be soon removed from the Wiki - because it is 'static' content which does not really qualify as wiki content). AIXM UML classes, data types or diagrams - these pages have been extracted automatically from the AIXM 5.1 UML and offer a simple way to navigate the model. They also offer some reverse links, such as the list of diagrams on which a class appears, which are usually not available in the the IBM Rational Rose Web tools that have been used in order to develop the AIXM 5.1 UML model.
  - (***Attention, this will be soon moved on the main AIXM web site***)AIXM UML clases/properties list as Excel - if of any interest, the Excel file contains the list of AIXM UML classes and their properties (attributes and associations)
  - AIXM UML as a high-level diagram - an attempt to show the high-level structure and the scope of the AIXM model in the form of a pseudo-hierarchical diagram.
  - AIXM 5.1 changes - you will find the list of changes that were implemented in AIXM 5.1.
  - (***Attention, this will be soon moved on the main AIXM web site***) BasicMessage - a basic container schema for AIXM features
  - Mappings - this section provides information about the mapping/conversion rules between the latest AIXM 5.1 version and other formats, in particular previous AIXM versions, AIP structure, Airport Mapping requirements (EUROCAE ED99A) etc.
  - (***Attention, this will be soon moved on the main AIXM web site***) Business Rules - this section provides information about available sets of business rules which can be used to perform a semantic validation of AIXM 5.1 datasets.

AIXM Purpose, Scope, Implementation and Future Evolution

AIXM Forum

Implementation Guidance: GML

- **Use of Geography Markup Language (GML) for Aviation Data**
    - Encoding rules / conventions
    - GML Profile
- OGC Aviation Domain WG
    - See OGC Aviation Page

CRS: *EPSG:4326*

*Example 1 – clockwise arc
(start angle < end angle)*

*Example 2 – counter-clockwise arc
(start angle > end angle)*

Network Manager
nominated by
the European Commission
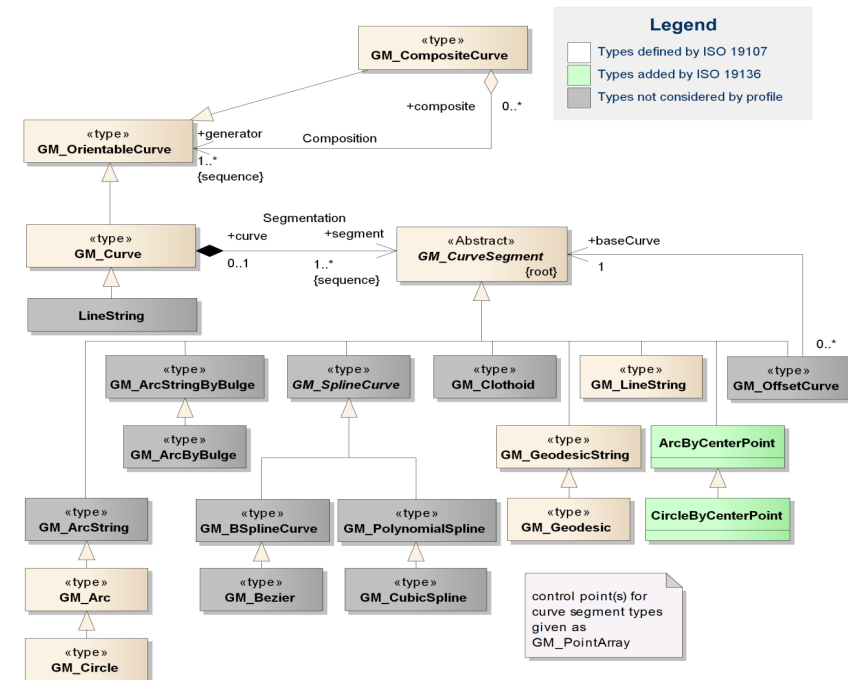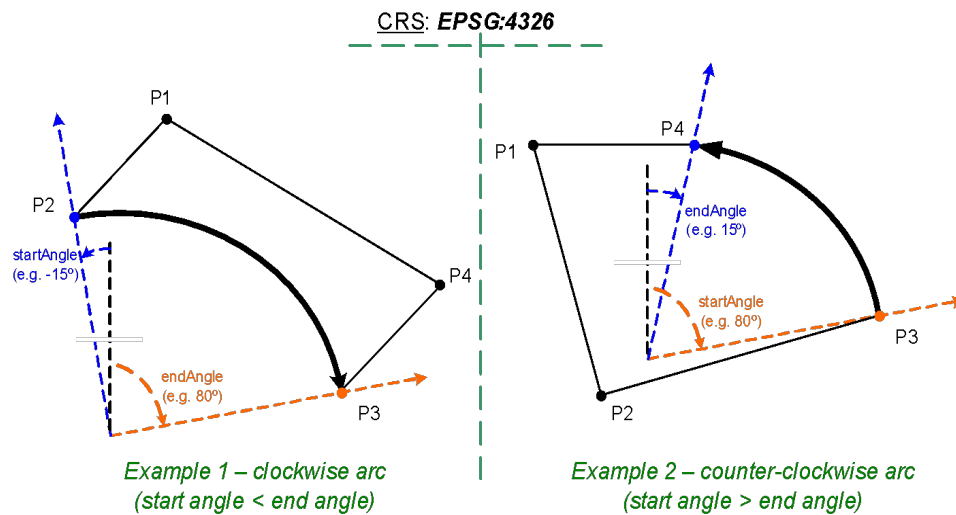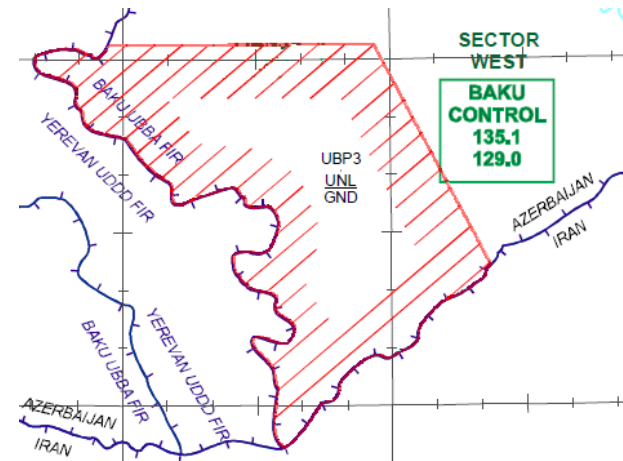
AIXM 5	AIXM version 5.1	Feature Identification and Reference

```
<gml:identifier
    codeSpace="urn:uuid:">a82b3fc9-4aa4-4e67-8def-
aaea1ac595j</gml:identifier>

    <aixm:clientAirspace xlink:href="#uuid.a82b3fc9-4aa4-4e67-8def-
aaea1ac595j"/>

    <aixm:clientAirspace
xlink:href="http://aim.faa.gov/services/AirspaceService#uuid.a82b3fc9-
4aa4-4e67-8def-aaea1ac595j"/>

    <aixm:clientAirspace xlink:href="urn:uuid:a82b3fc9-4aa4-4e67-8def-
aaea1ac595j"/>
```

AIXM 5

Feature Identification and Reference
- use of xlink:href and UUID -

Implementation Guidance: Metadata

- **Metadata Profile**
  - **Requirements for Aviation Metadata**
  - **Guidance on the Aviation Metadata Profile**

Requirement/Source	Annex 15	ADQ	INSPIRE IR	OWS-6
5.1.1 Resource Title			■	
5.1.2 Resource Abstract			■	
5.1.3 Resource Language			■	
5.2.1 Topic Category			■	
5.3.1 Geographic Bounding Box	■		■	■
5.3.2 Spatial Reference System		■		
5.4.1 Temporal Extent			■	■
5.4.2 Date of Publication		■		
5.4.3 Date of Last Revision			■	
5.4.4 Date of Creation			■	
5.4.5 Temporal Reference System	■			
5.5.1 Lineage	■	■		
5.5.2 Accuracy of Numerical Data		■		
5.6.1 Conditions Applying to Access and Use		■	■	
5.6.2 Limitations on Public Access		■		
5.7.1 Responsible Party		■		
5.7.2 Responsible Party Role		■		
5.8.1 Metadata Point of Contact			■	
5.8.2 Metadata Date			■	
5.8.3 Metadata Language			■	

Verification & Validation of AIXM 5.1

AIXM 5.1 UML → **AIXM 5.1 XSD**

Cloud:
- Does the data make sense?
- Is it compliant with international standards ?
- Do I respect recommended practices?
- …

=

Syntactic check

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

AIXM 5.1 XML

Airport features

Semantic check

Business Rules

AIXM 5.1 Business Rules
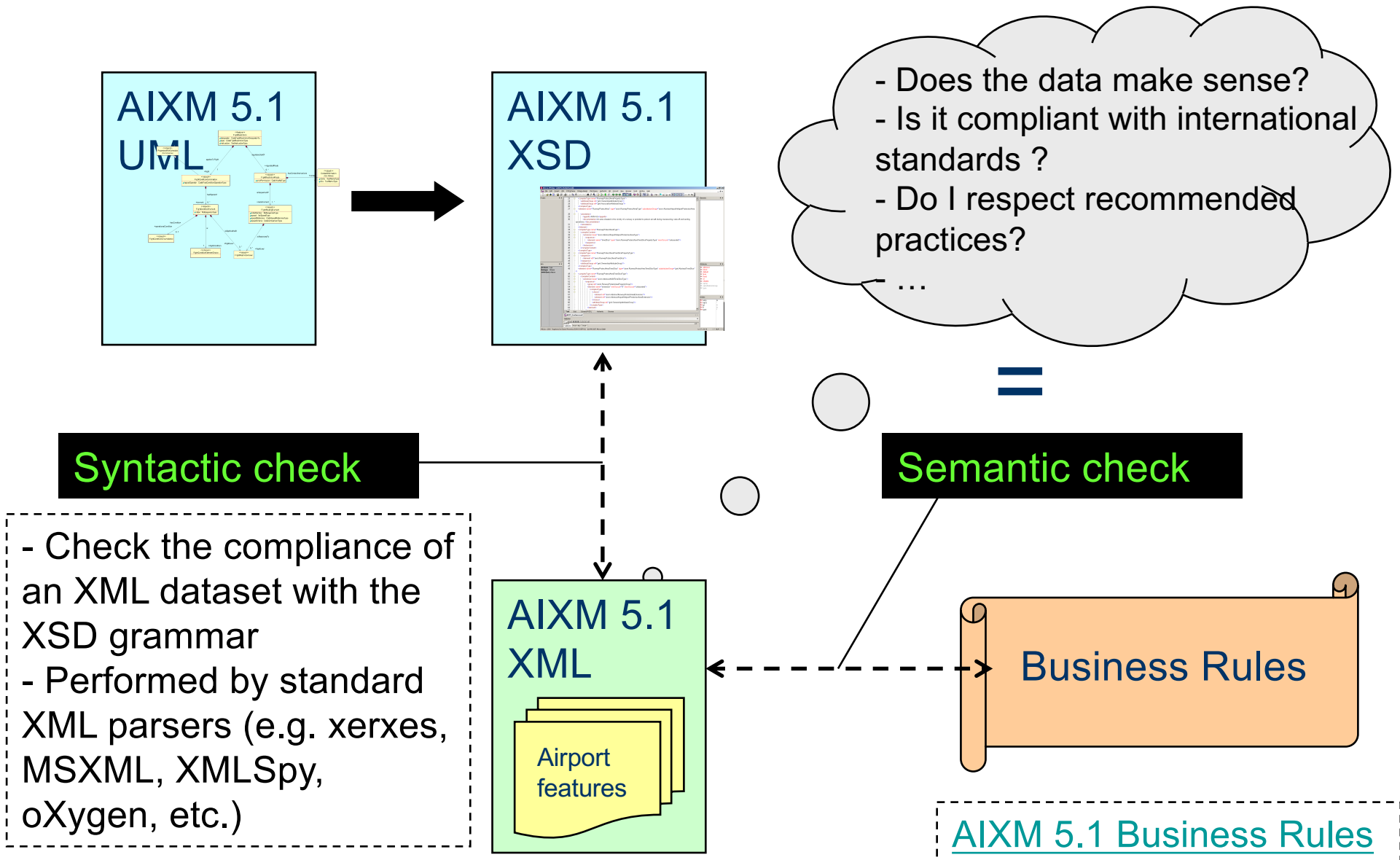
Aeronautical Data Quality (ADQ)

- ADQ
  - COMMISSION REGULATION (EU) No 73/2010
    - *"laying down requirements on the quality of aeronautical data and aeronautical information for the single European sky"*
    - Basically; Turning Annex 15 into European Law
    - Compliance dates: 2013-2017

  - Means of Compliance – EUROCONTROL Specifications:

    - Electronic AIP (eAIP)
    - Aeronautical Information Exchange (AIX)
      - ***AIXM 5.1 is proposed as compliant model***
    - Data Quality Requirements (DQR)
    - Data Assurance Levels (DAL)
    - Data Origination (DO)

AIXM 5.1 Mappings: AIP to AIXM 5.1

- **Aeronautical Information Publication (AIP) into AIXM 5.1**
  - See AIXM Mappings
  - Status: review in progress

A.1.1   ENR

AIP	Status	Mapping with AIXM v5.1
PART 2 — EN-ROUTE (ENR)		All mappings are in the sub-sections
ENR 0.		All mappings are in the sub-sections
ENR 0.6 Table of contents to Part 2		Not applicable. AIP document editorial element.
ENR 1. GENERAL RULES AND PROCEDURES		All items mapped
ENR 1.1 General rules		All items mapped
ENR 1.2 Visual flight rules		All items mapped
ENR 1.3 Instrument flight rules		All items mapped
ENR 1.4 ATS airspace classification		All items mapped
ENR 1.5 Holding, approach and departure procedures		All items mapped
ENR 1.5.1 General		All items mapped
ENR 1.5.2 Arriving flights		All items mapped
ENR 1.5.3 Departing flights		All items mapped
ENR 1.6 ATS surveillance services and procedures		All items mapped
ENR 1.6.1 Primary radar		All items mapped
ENR 1.6.2 Secondary surveillance radar (SSR)		All items mapped
ENR 1.6.3 Automatic dependent surveillance — broadcast (ADS-B)		All items mapped

1. **Item to be mapped** "obstacle position, represented by geographical coordinates in degrees, minutes and seconds;"

   AIXM 5.1 Mapping:

   Figure 297. Short Mapping Description

   ```
   VerticalStructure
     .part
       .VerticalStructurePart
         .horizontalProjection
           .VerticalStructurePartGeometry
             .location
               .ElevatedPoint[coordinates=""]
   ```

. *AIXM 5.1 Mapping of AIP-TS-ENR-5.4/3*

Class	VerticalStructure			
Association	part(isMadeOf)			
	Class	VerticalStructurePart		
	Association	horizontalProjection(isRepresentedAs)		
		Class	VerticalStructurePartGeometry	
		Association	location(hasPointShape)	
			Class	ElevatedPoint
			Attribute (name and value)	coordinates = ""

Network Manager
nominated by
the European Commission

AIXM 5.1 Mappings: Airport Mapping to AIXM 5.1

- **Airport Mapping** Requirements
  - See AIXM Mappings
  - ED 99/DO 272 (A/B/C) into AIXM 5.1
  - Status: review in progress
    - Includes an AIXM 5.1-AMDB extension
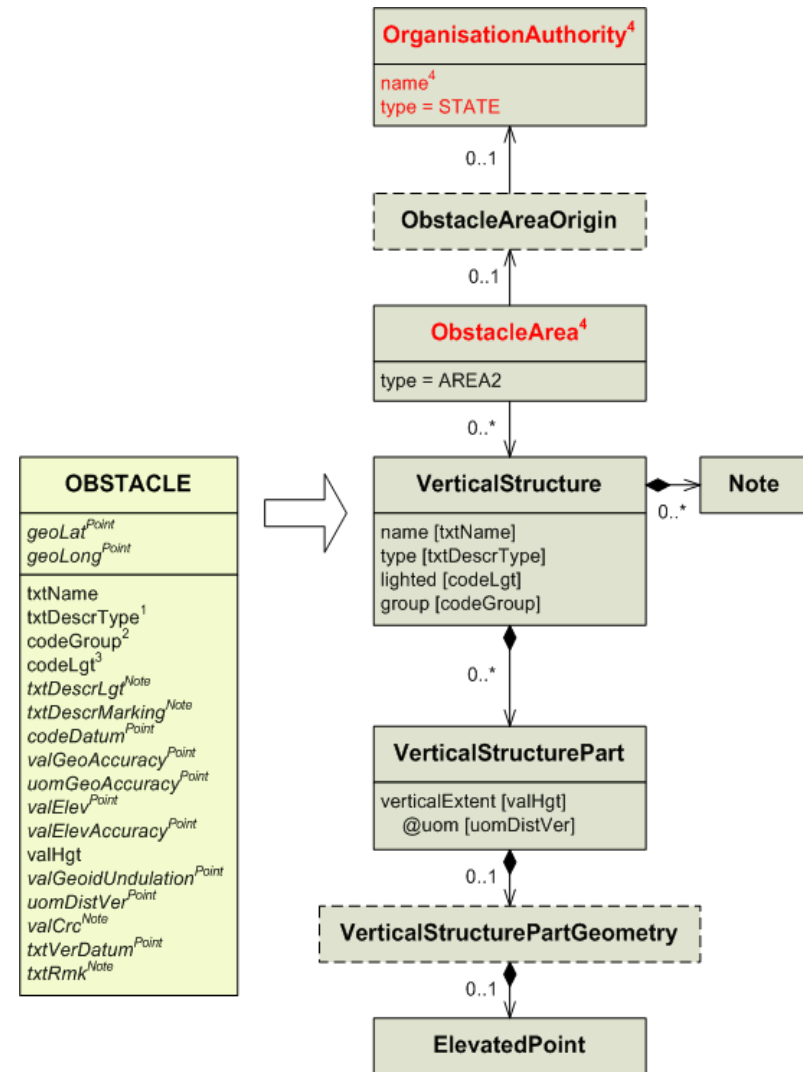
1.1 AM_RUNWAYELEMENT

ED-99A Definition: Part of a runway.

AIXM 5.1 Definition: Runway element may consist of one ore more polygons not defined as other portions of the runway class.
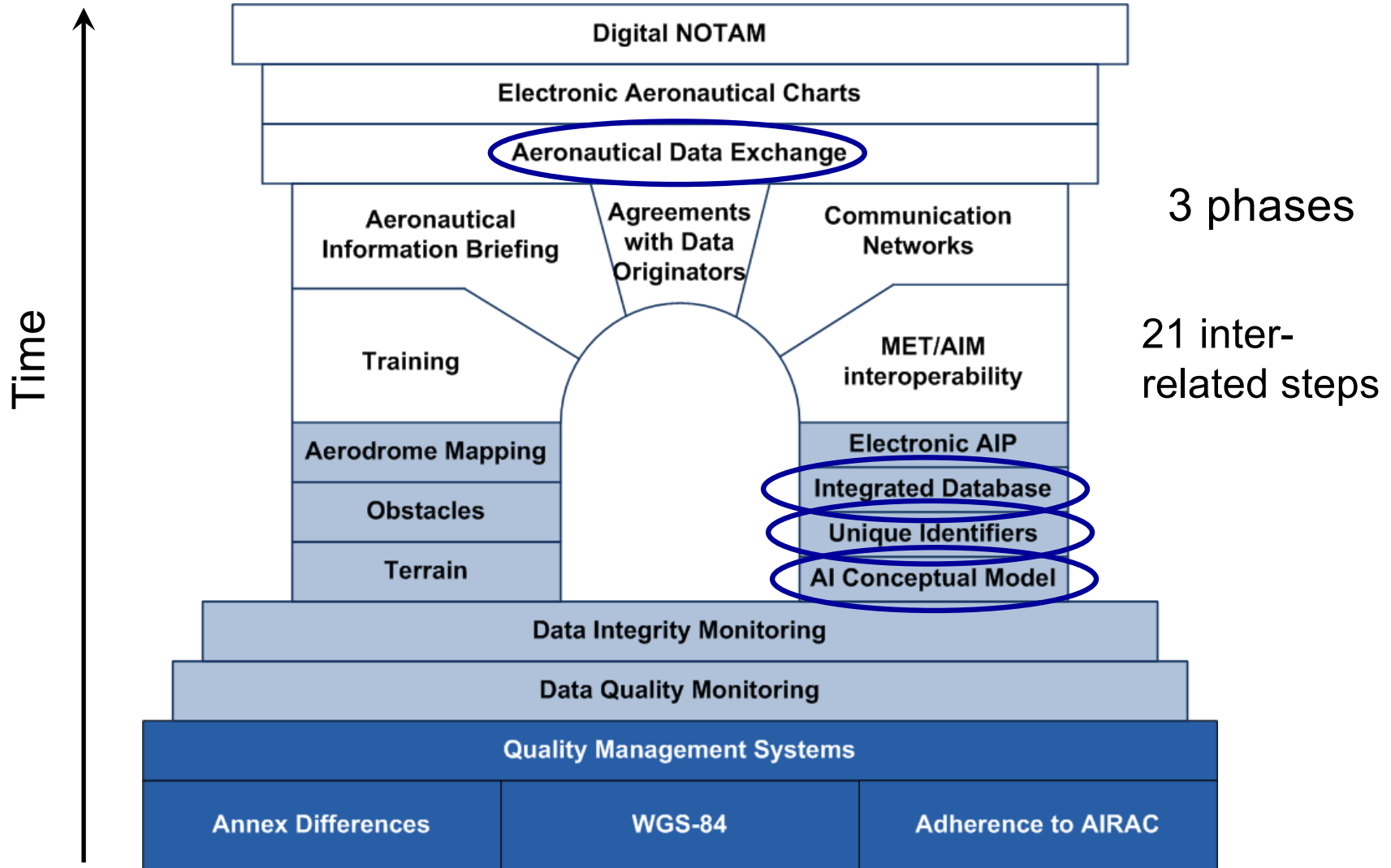
ED-99A	AIXM 5.1
AM_RunwayElement	RunwayElement[type='NORMAL']
idarpt	associatedRunway.Runway.associatedAirportHeliport.AirportHeliport.locationIndicatorICAO
idrwy	associatedRunway.Runway.designator
pcn	surfaceProperties.SurfaceCharacteristics.classPCN
width	width
	Note: there is also nominalWidth on Runway
length	length
	Note: there is also nominalLength on Runway
surftype	surfaceProperties.SurfaceCharacteristics.composition
	AND
	surfaceProperties.SurfaceCharacteristics.preparation
geopoly	extent.ElevatedSurface
feattype	*Note: Can be implied*
vacc	extent.ElevatedSurface.verticalAccuracy
vres	extent.ElevatedSurface.*verticalResolution*
hacc	extent.ElevatedSurface.horizontalAccuracy
hres	extent.ElevatedSurface.*horizontalResolution*
integr	*integrity*
source	*source*
	OR
	gmd:MD_Metadata.gmd:dataQualityInfo.gmd:lineage.gmd:LI_Lineage.gmd:processStep.gmd:LI_ProcessStep
	Note: Needs processor with a role set to "originator".
revdate	*revisionDate*

ED-99B	AIXM 5.1
idnumber	identifier
restacn	availability.ManoeuvringAreaAvailability.usage.ManoeuvringAreaUsage[type="FORBID"].selection.ConditionCombination.aircraft.AircraftCharacteristics.typeAircraftICAO

ED-99C	AIXM 5.1
stfeat	featureLifetime.gml:TimePeriod.gml:beginPosition
endfeat	featureLifetime.gml:TimePeriod.gml:endPosition
stvalid	validTime.gml:TimePeriod.gml:beginPosition
endvalid	validTime.gml:TimePeriod.gml:endPosition
interp	interpretation
restacft [= restacn]	*Note: See restacn above*

AIXM 5.1 Mappings: Airport Mapping to AIXM 5.1

- **AIXM 4.5** Conversion Guidelines
  - See AIXM Mappings
  - Status: released
  - More detailed mapping developed by EAD
    - Based on actual EAD data

ICAO AIS to AIM Roadmap

Time

Digital NOTAM

Electronic Aeronautical Charts

Aeronautical Data Exchange

Aeronautical Information Briefing

Agreements with Data Originators

Communication Networks

Training

MET/AIM interoperability

Aerodrome Mapping

Electronic AIP

Obstacles

Integrated Database

Unique Identifiers

Terrain

AI Conceptual Model

Data Integrity Monitoring

Data Quality Monitoring

Quality Management Systems

Annex Differences

WGS-84

Adherence to AIRAC

3 phases

21 inter-related steps

AIXM Change Control Board - mandate

Transparency

- Stakeholder representation
    - States, Military
    - ANSP, Service Providers
    - Airlines, Airports
    - Manufacturing industry

- Decisions by consensus!
    - Change proposals developed collectively
    - If no serious disagreement with a change proposal is notified (silent process) -> adopted
    - A widely acceptable solution needs to be found for any issue!

Network Manager
nominated by
the European Commission

Registration process

- CCB
  - [Follow the link](#)
  - One representative per organisation/company (or Department for very large organisations
  - No deadline, you are welcome at any time!
- CCAB
  - Eurocontrol and FAA will contact organisations/groups as indicated in the Charter to seek participation in the CCAB
- ICAO Information Management Panel (IMP)
  - Works on a new Governance concept for all XMs (AIXM, FIXM, eWXXM)
  - To be proposed as a Panel deliverable
  - AIXM CCB reports to the IMP once per year

Network Manager
nominated by
the European Commission

Future AIXM Versions

- Finalised
  - Minor Release AIXM 5.1.1 in 2016
    - XML Schema improvements/corrections, such as:
      - Improve the documentation (including the schema annotations)
      - bug corrections (spelling errors)
      - Regeneration of the schema from Sparks Enterprise Architect
      - Regeneration of application schemas
    - UML model
      - No changes to classes, attributes, associations (except few additions of values)
      - Improvements of definitions
      - Migration from RationalRose (IBM) to EA (Sparx)

Future AIXM Versions

- In development
  - Regular update AIXM 5.2 by mid 2018

    - ## backwards compatible with AIXM 5.1
      - deprecation instead of simple removal

      - allow new classes, properties, associations where **operationally** required

  - Including mapping rules to AIXM 5.1
    - eventually mapping code (XSLT) provided as part of the release

Questions?