Global Harmonization Through Collaboration

Aeronautical Information Exchange Model (AIXM) - Updates

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Date: *August 28, 2012*

EUROCONTROL

Federal Aviation Administration

AIR TRANSPORTATION INFORMATION EXCHANGE CONFERENCE - (FEATURING AIXM, WXXM AND FIXM)

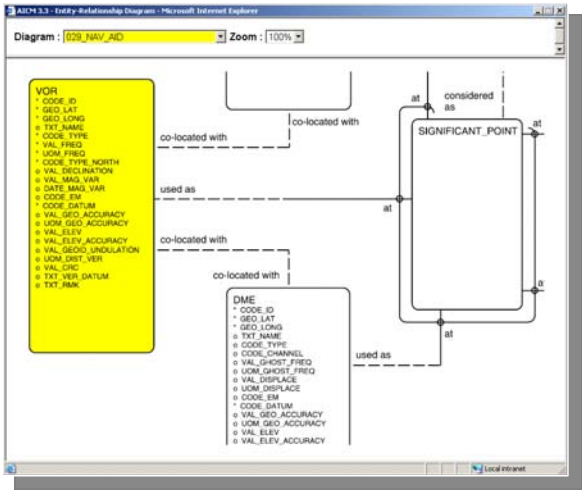
August 28, 2012 - August 31, 2012
NOAA Auditorium and Science Center
Silver Spring, Maryland

Content

- AIXM Versions in use
- AIXM 5.1 progress since ATIEC 2011
  - Encoding guidelines
  - Mappings guidelines
  - Digital NOTAM Event Specification
  - Business Rules
  - Support: tools, training, sample data, etc.
  - Known Extensions
- Global adoption
- Future versions

Versions in use - AIXM 4.5

- Published: 2005
  - Entity/Relationship
  - Custom XML schema
  - Core AIP data
- Use:
  - European AIS Database (EAD) and national systems
  - A few national systems world-wide



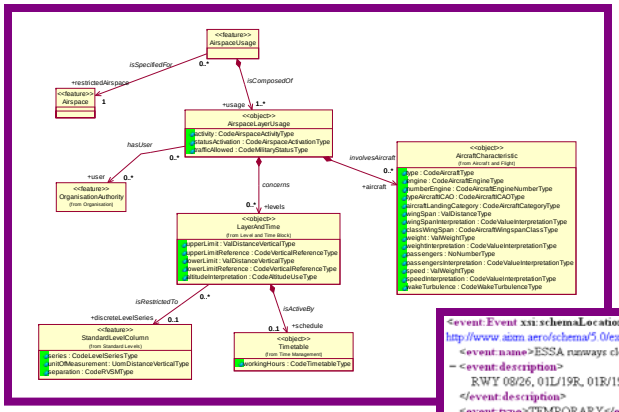

```
<AIXM-Snapshot>
    <Vor>
        <VorUid>
            <codeID>AML</codeID>
            <geoLat>34.3928N</geoLat>
            <geoLon>123.4333W</geoLon>
        </VorUid>
    …
</AIXM-Snapshot>
```

Versions in use – AIXM 5.0

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

- Published: MAR 2008
- UML Model
- GML Schema
- Full AIP/NOTAM data
  - Including obstacle, airport mapping, etc.
- Metadata
- Extensibility
- Use:
  - Partially, by FAA, NGA, anyone else?

Aeronautical Information Exchange Model



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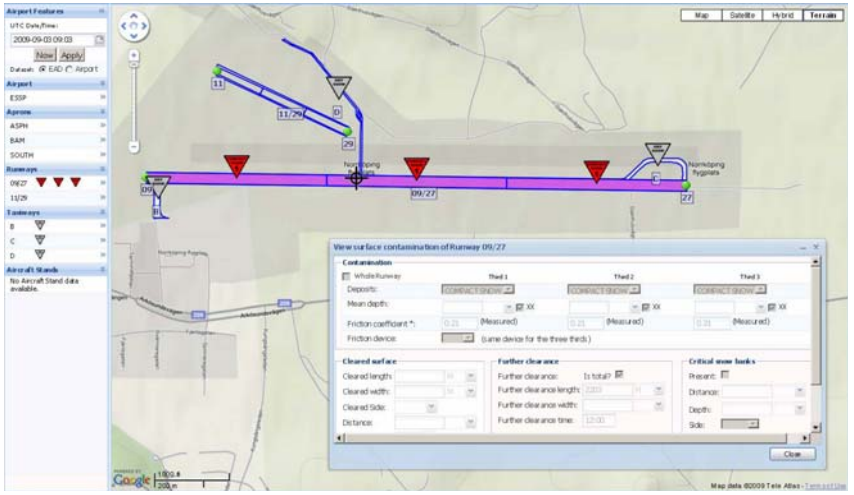
Versions in use – AIXM 5.1

- Published: FEB 2010
- Update of AIXM 5.0
  - Usage/availability model
  - Notes vs. descriptions
  - Other adjustments to facilitate Digital NOTAM encoding
- Use
  - FAA – Digital NOTAM
  - Eurocontrol/NM (CFMU) and EAD
  - In implementation in several national systems world-wide
  - Industry solutions in development



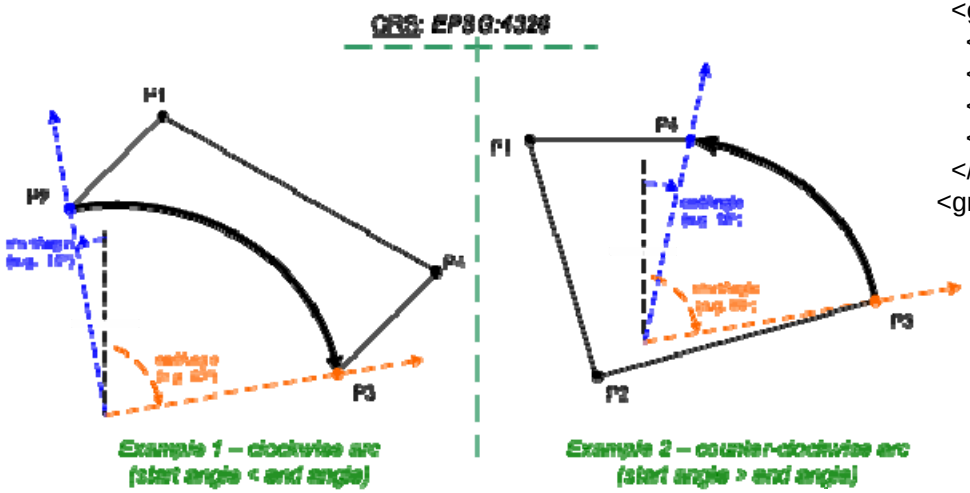
AIXM 5.1 Guidelines

- AIXM Temporality Concept (FEB 2010)
- Metadata Guidelines for Aviation Data (MAR 2011)
- Feature Identification and Reference (APR 2011)
- Use of GML for Aviation Data (MAY 2012)

AIXM 5.1 Guidelines

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

- Guidance and Profile of GML for use with Aviation Data
  - Published: MAY 2012 by OGC (produced by the Aviation Domain WG)
  - Status: OGC Discussion Paper (https://portal.opengeospatial.org/files/?artifact_id=47859)
  - 1st part - Encoding guidelines for positions, lines, areas, circles, arcs, references to Geo Border, etc.




```
</gml: GeodesicString>
  <gml:ArcByCenterPoint gml:id="A01">
    <gml:pos>lat_Pc long_Pc</gml:pos>
    <gml:radius uom="m">radius</gml:radius>
    <gml:startAngle uom="deg">calculated_start_angle</gml:startAngle>
    <gml:endAngle  uom="deg">calculated_end_angle</gml:endAngle>
  </gml:ArcByCenterPoint>
<gml:GeodesicString>
```

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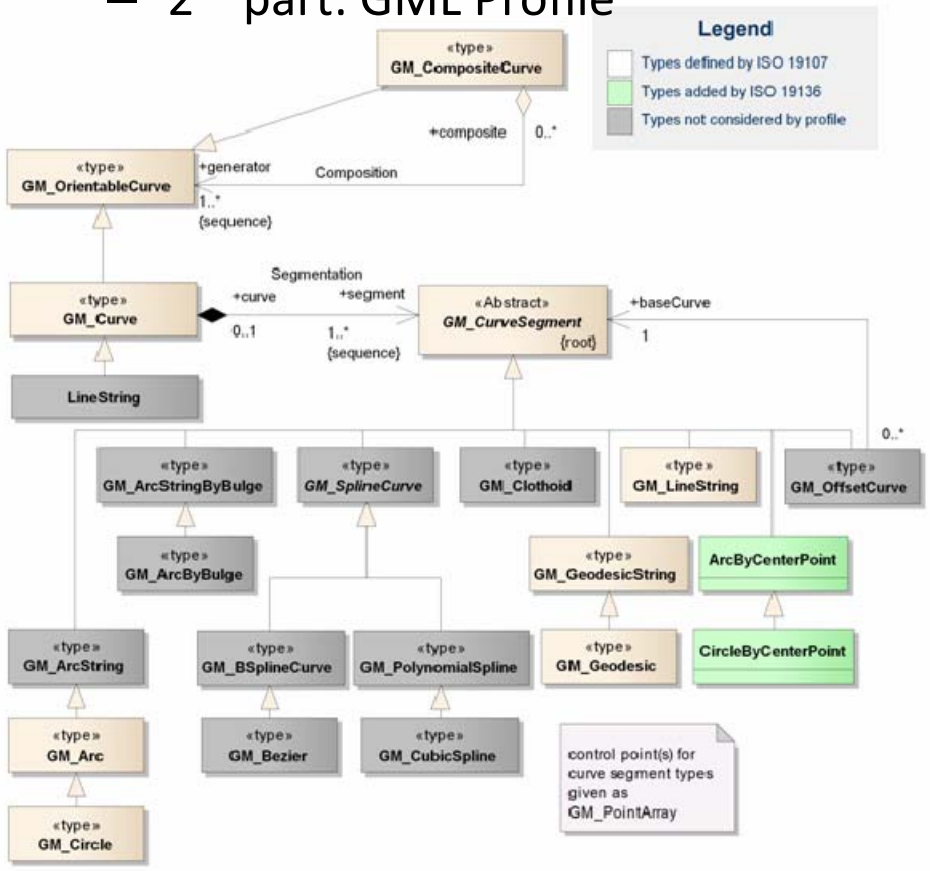
AIXM 5.1 Guidelines

- Guidance and Profile of GML for use with Aviation Data
  - 2nd part: GML Profile



XSD Element	gml:Circle
Type	gml:CircleType
BaseType	gml:ArcType (see section 9.4.13)
Restriction	Use of the child elements "gml:pointRep" and "gml:coordinates" is deprecated.
Usage	To define a circle that is given via three control points – usually to define the boundary of a circular airspace.
Definition	A Circle is an arc whose ends coincide to form a simple closed loop. The three control points shall be distinct non-co-linear points for the circle to be unambiguously defined. The arc is simply extended past the third control point until the first control point is encountered.
Comments	Other than CircleByCenterPoint (see section 9.4.12), Circle has a well defined direction.
Used in	As child of GM_Arc (see section 9.4.13), usually to represent a segment of a GM_Curve (see section 9.4.9) that forms a circle.
XML Schema File	(./ISO_19136_Schemas/) geometryPrimitives.xsd

XML Schema Component	`<element name="Circle" type="gml:CircleType" substitutionGroup="gml:Arc"/>`
	`<complexType name="CircleType">`
	`<complexContent>`
	`<extension base="gml:ArcType"/>`
	`</complexContent>`
	`</complexType>`

Example	`<gml:Circle …>`
	`<gml:posList>0 1 -1 0 0 -1</gml:posList>`
	`</gml:Circle>`

AIXM 5.1 Guidelines

- Requirements for Aviation **Metadata** & Guidance on the Aviation Metadata Profile
  - Published: MAR 2011 by the OGC Aviation Domain WG
  - Status: OGC Discussion Paper (http://portal.opengeospatial.org/files/?artifact_id=41667 and http://portal.opengeospatial.org/files/?artifact_id=41668)

AIXM 5.1 Guidelines

- Requirements for Aviation Metadata

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				

AIXM 5.1 Guidelines

- Guidance on the Aviation Metadata Profile
  - maps the Requirements for an Aviation Metadata to ISO 19115 elements
  - Includes XML examples

```
<gmd:MD Metadata>
...
  <gmd:identificationInfo>
    <gmd:MD_DataIdentification>
      <gmd:citation>
        <gmd:CI_Citation>
          <gmd:title>
            <gco:CharacterString>SDO
     Update</gco:CharacterString>
          </gmd:title>
        </gmd:CI_Citation>
      </gmd:citation>
    </gmd:MD_DataIdentification>
  </gmd:identificationInfo>
...
</gmd:MD_Metadata>
```

Requirement	Reference	5.1.1
	Element Name	Resource Title
	Obligation / Condition	Mandatory
	Multiplicity	[1]
ISO 19115	Number	360
	Name	title
	Definition	Name by which the cited resource is known
	XPath	gmd:MD_Metadata/gmd:identification/ gmd:MD_DataIdentification/gmd:citation/ gmd:CI_Citation/gml:title/gco:CharacterString
	Data type	CharacterString
	Domain	Free text
	Example	SDO Update 27
Implementing Instructions		-
See Diagrams		2, 3

AIXM 5.1 Guidelines

- Feature Identification and Reference
  - Published: APR 2011
  - Recommendations:
    - UUID for gml:identifier

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

    - Xlink:href with abstract references

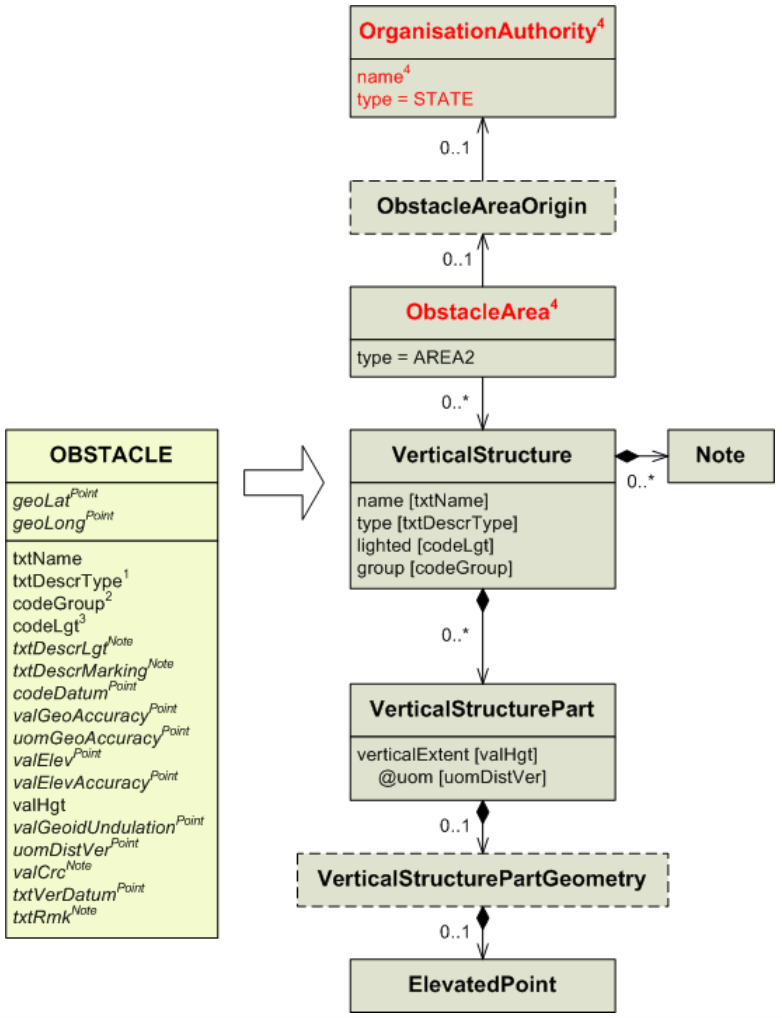
```
<aixm:clientAirspace xlink:href="urn:uuid:a82b3fc9-4aa4-4e67-8def-aaea1ac595j"/>
```

    - Xlink:href with local references

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

AIXM 5.1 Mappings

- AIXM 4.5 Conversion Guidelines
  - See www.aixm.aero/wiki -> Mappings
  - Status: proposed release
  - More detailed mapping developed by EAD
    - Based on actual EAD data



AIXM 5.1 Mappings

- Aeronautical Information Publication (AIP) into AIXM 5.1
  - See www.aixm.aero/wiki -> 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 = ""`

AIXM 5.1 Mappings

- **Airport Mapping** Requirements
  - See www.aixm.aero/wiki -> Mappings
  - ED 99/DO 272 (A/B/C) into AIXM 5.1
  - Status: review in progress
    - Includes an AIXM 5.1-AMDB extension

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*

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*

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Digital NOTAM Event Specification

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

Event data

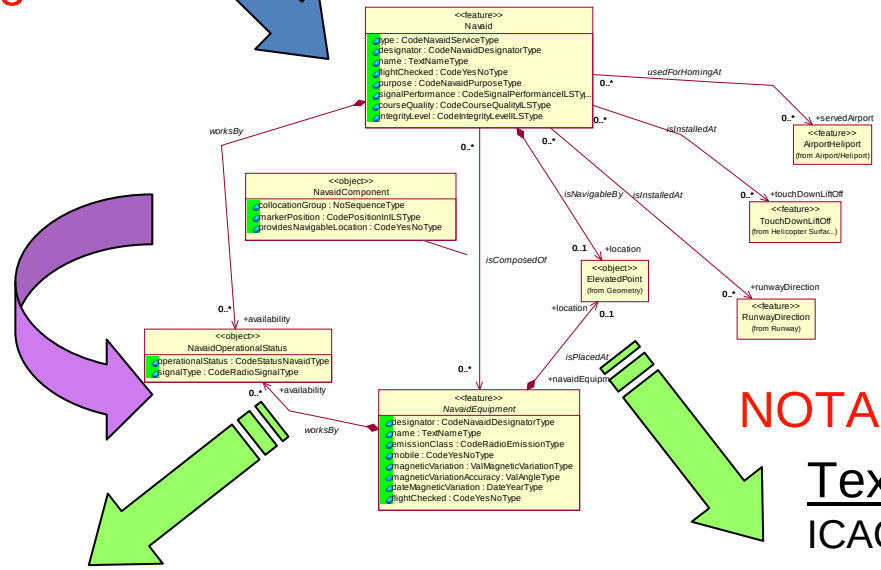
Restricted area North of Sjaellands Odde
TEMPORARY RESTRICTED AREA IS ESTABLISHED
daily from 08:00-17:00 between 07 NOV and 17 NOV
AS FOLLOWS NORTH OF SJAELLANDS ODDE:
560028N 0111656E - 560643N 0111026E - 561500N 0112400E -
561500N 0113600E -560112N 0114736E - 555730N 0113830E - 560028N 0111656E.
between SFC and 60000 FT AMSL
RELEVANT ATS UNITS REF. AIP DENMARK ENR 5.1 ITEM 3:
AARHUS APP/TWR, ACC KOEBENHAVN

Target: application developers !

Rules
Rules
Rules

Data encoding rules

Data validation rules



NOTAM production rules

Digital NOTAM

AIXM 5.1 encoded data output

```
<message:AIXMBasicMessage xmlns:message="http://www.aixm.aero/schema/5.1/message" x
 <message:hasMember>
  <event:Event gml:id="e01">
   <event:timeSlice>
    <event:EventTimeSlice gml:id="e01-1">
     <gml:validTime>
      <!-- Note that this time should be the same as for the associated feature, see
      <gml:TimePeriod gml:id="e01-2">
       <gml:beginPosition>2009-11-07T08:00:00</gml:beginPosition>
       <gml:endPosition>2009-11-17T17:00:00</gml:endPosition>
      </gml:TimePeriod>
     </gml:validTime>
     <aixm:interpretation>BASELINE</aixm:interpretation>
     <aixm:sequenceNumber>1</aixm:sequenceNumber>
     <aixm:featureLifetime>
      <gml:TimePeriod gml:id="e01-3">
       <gml:beginPosition>2009-11-07T08:00:00</gml:beginPosition>
       <gml:endPosition>2009-11-17T17:00:00</gml:endPosition>
      </gml:TimePeriod>
     </aixm:featureLifetime>
```

Text NOTAM

ICAO Format

(Snnnn/yy NOTAMN
Q) EKDK/QRRCA/IV/BO /W /000/600/5606N01130E012
A) EKDK B) 0711010800 C) 0711011100
E) TEMPORARY RESTRICTED AREA ESTABLISHED
AS FOLLOWS (NORTH OF SJAELLANDS ODDE):
560028N 0111656E - 560643N 0111026E - 561500N 0112400E -
561500N 0113600E -560112N 0114736E - 555730N 0113830E -
560028N 0111656E

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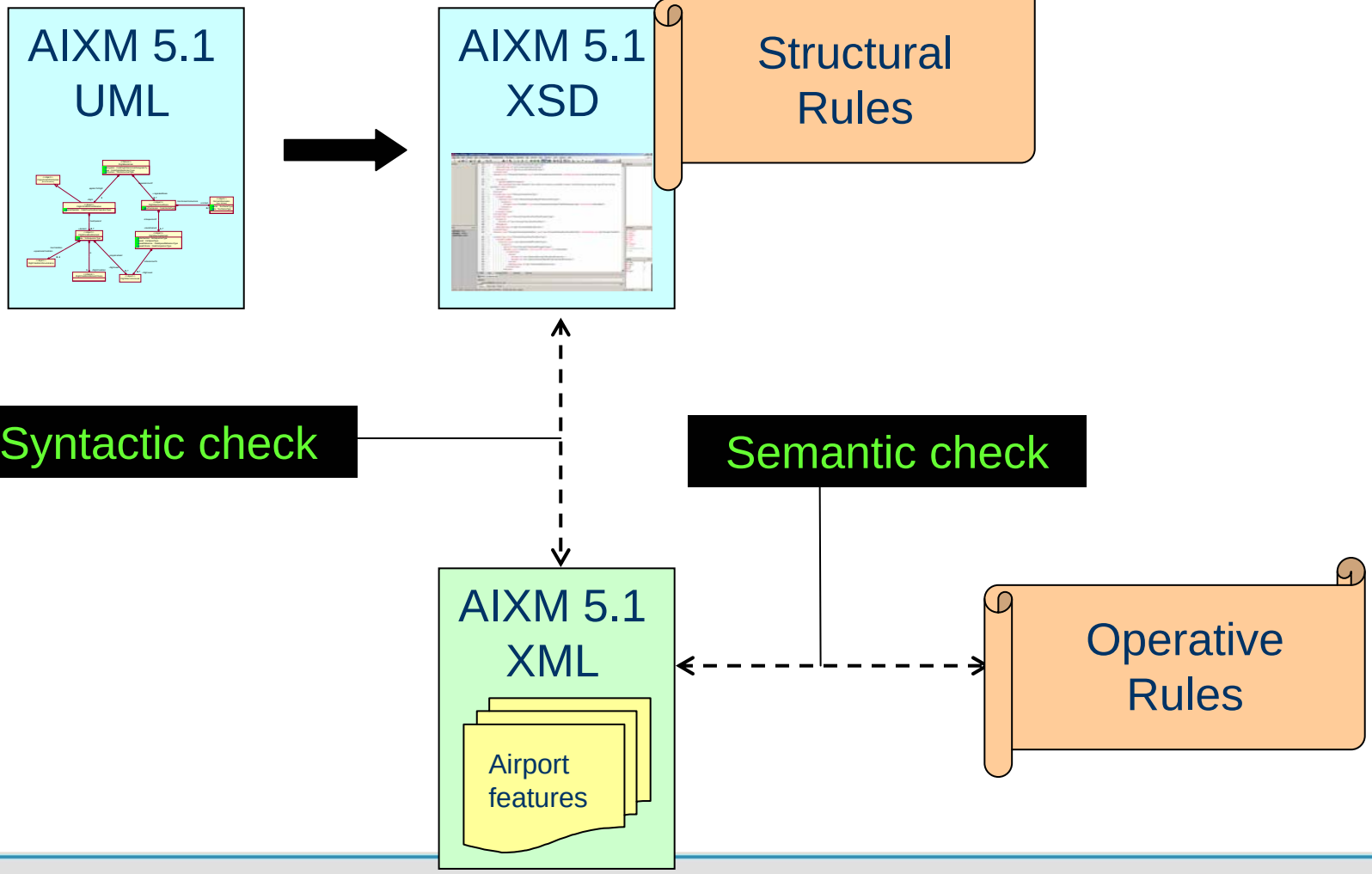
Business Rules



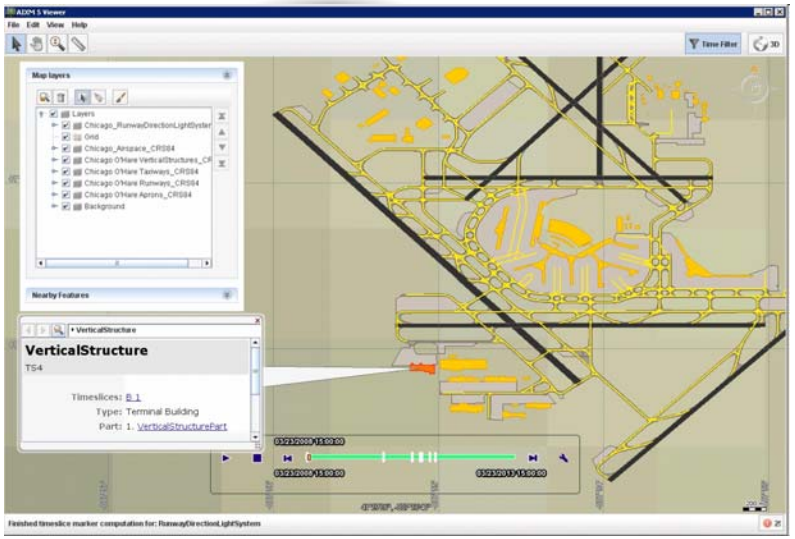
Business Rules

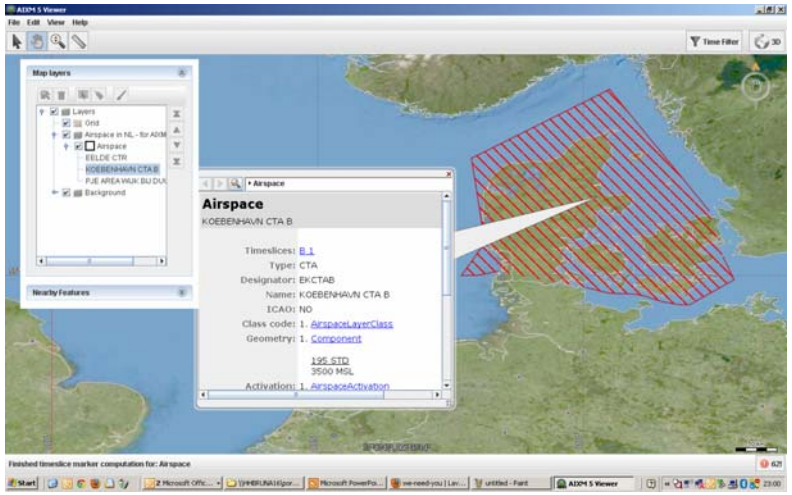
- Sources
  - AIXM 4.5 business rules
    - Include mandatory attributes/associations from AIXM 4.5
  - ICAO Annex 10, 11, 14 and 15 and the ICAO PANS-OPS
  - Temporality Concept document
  - Activation/Usage concept
  - GML profile?
  - Arinc424 and PANS-OPS
- Rules
  - Using Semantics of Business Vocabulary and Business Rules (SBVR)
  - Including, where feasible, an implementation of the rule in Schematron language
  - See www.aixm.aero -> Business Rules (Excel)
  - Status: Work in progress

Support to implementation

- FAA AIXM Viewer

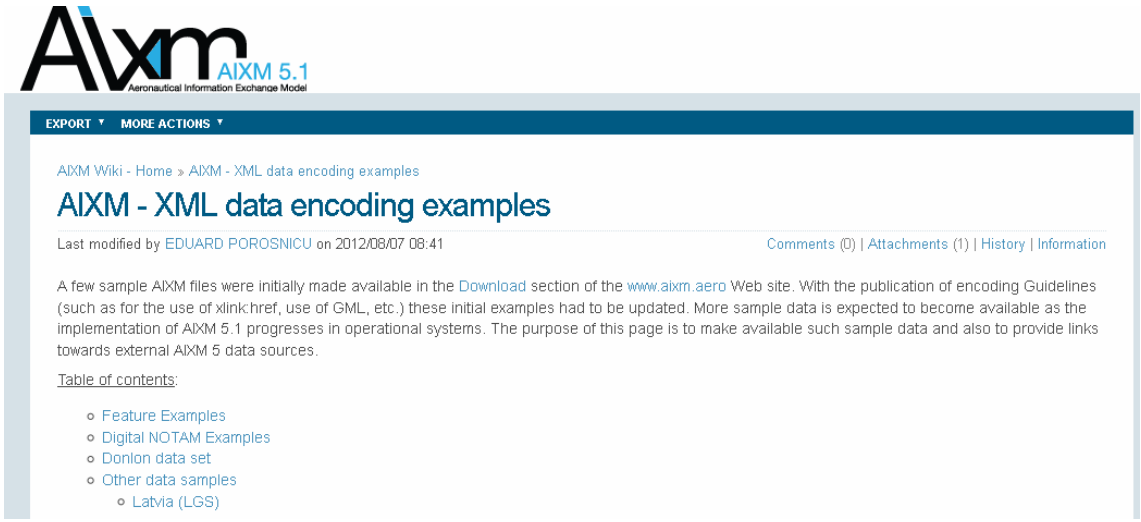
Traffic Analysis	
Total visits:	1,087
Total page views:	1,345
Average visits per day:	5
Average visits per week:	32
Average visits per month:	139
Average pages viewed per day:	6
Highest volume time of day:	15:00 - 16:00
Highest volume day of the week:	Wednesday
Highest volume day:	Tuesday, 17 Jan. 2012





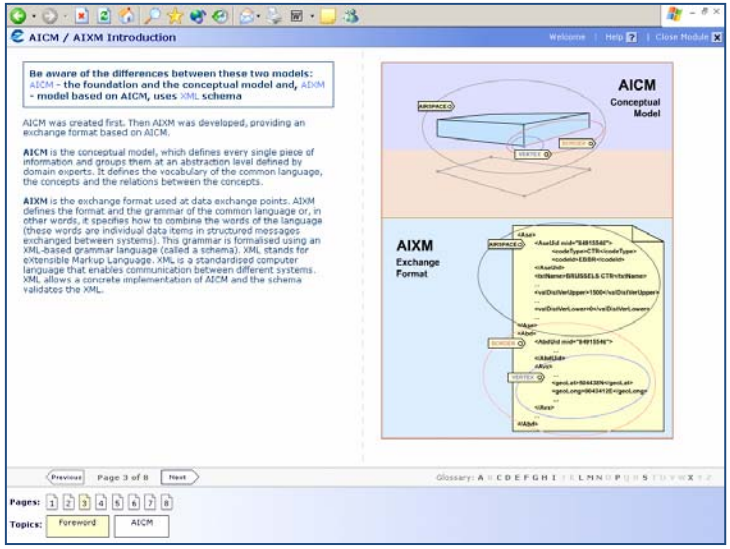
Support to implementation

- AIXM 5.1 Sample Data
  - See www.aixm.aero/wiki -> XML Encodings
  - Individual feature encodings
  - "Donlon" Data Set
  - Digital NOTAM
  - Other samples -> Yours are welcome!



Support to implementation

- Training material
  - AIXM 4.5 CBT still partially useful
  - AIXM Wiki
  - AIXM Classes and Seminars
    - See www.aixm.aero ->Archive



Support to implementation

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

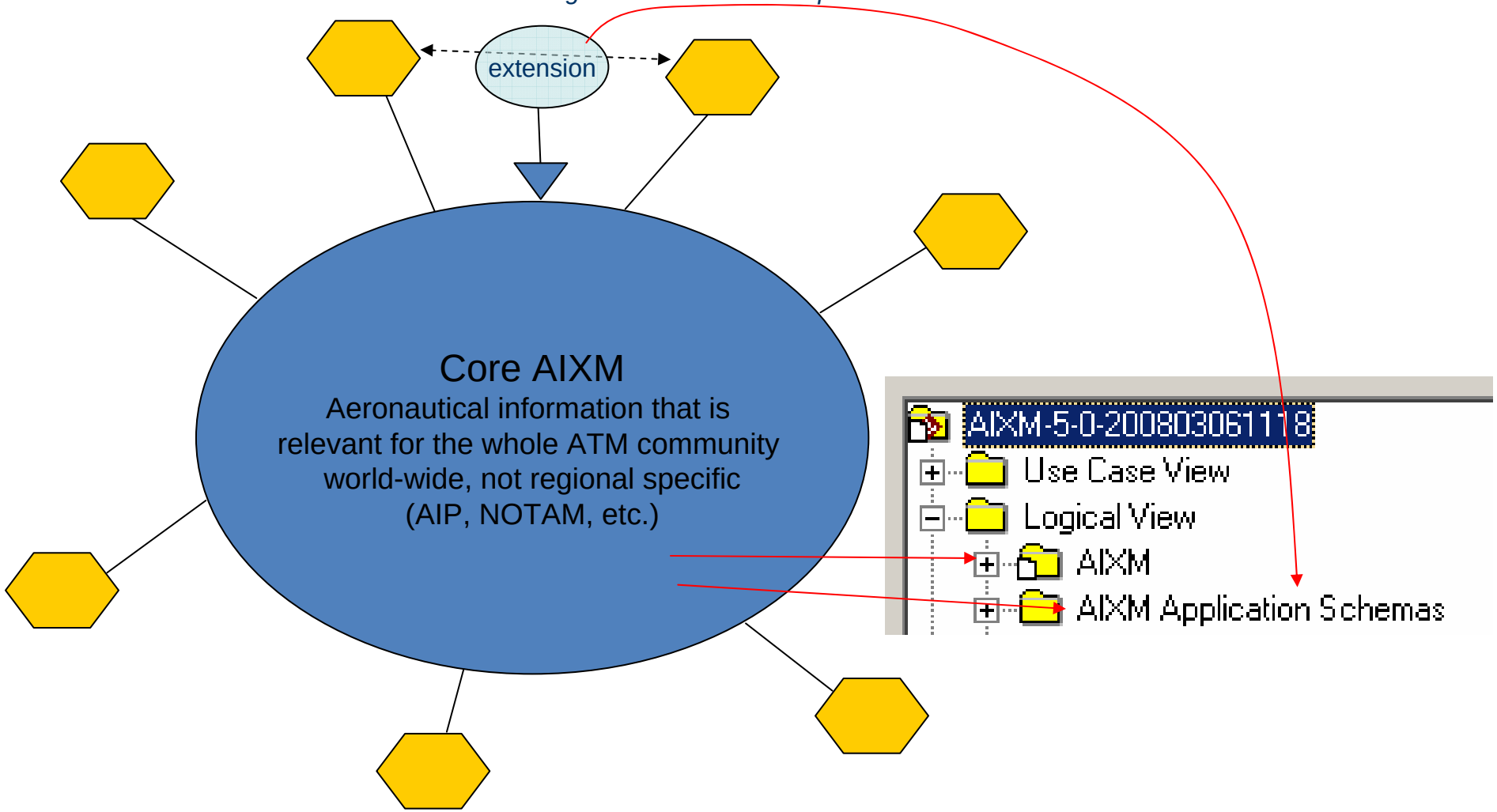
- AIXM Forum
  - 1800 members
  - World-wide coverage
  - 5-20 messages per month in 2011-2012
  - registration required
    - also gives access to the FAA AIXM Viewer

Support to implementation

- Code generation using AIXM XML Schema (.xsd)
  - Popular topic on AIXM Forum
  - Difficult code generation if using:
    - Full XSD for Metadata
    - Full XSD for GML
    - Full XSD for AIXM
- Proposed solution : Profile
  - Sub-set of the GML schema
    - including/excluding sub-set of the GMD/GCO schema
  - AIXM Profiling possibility
    - Select features of interest
  - Organised as a open-source project?

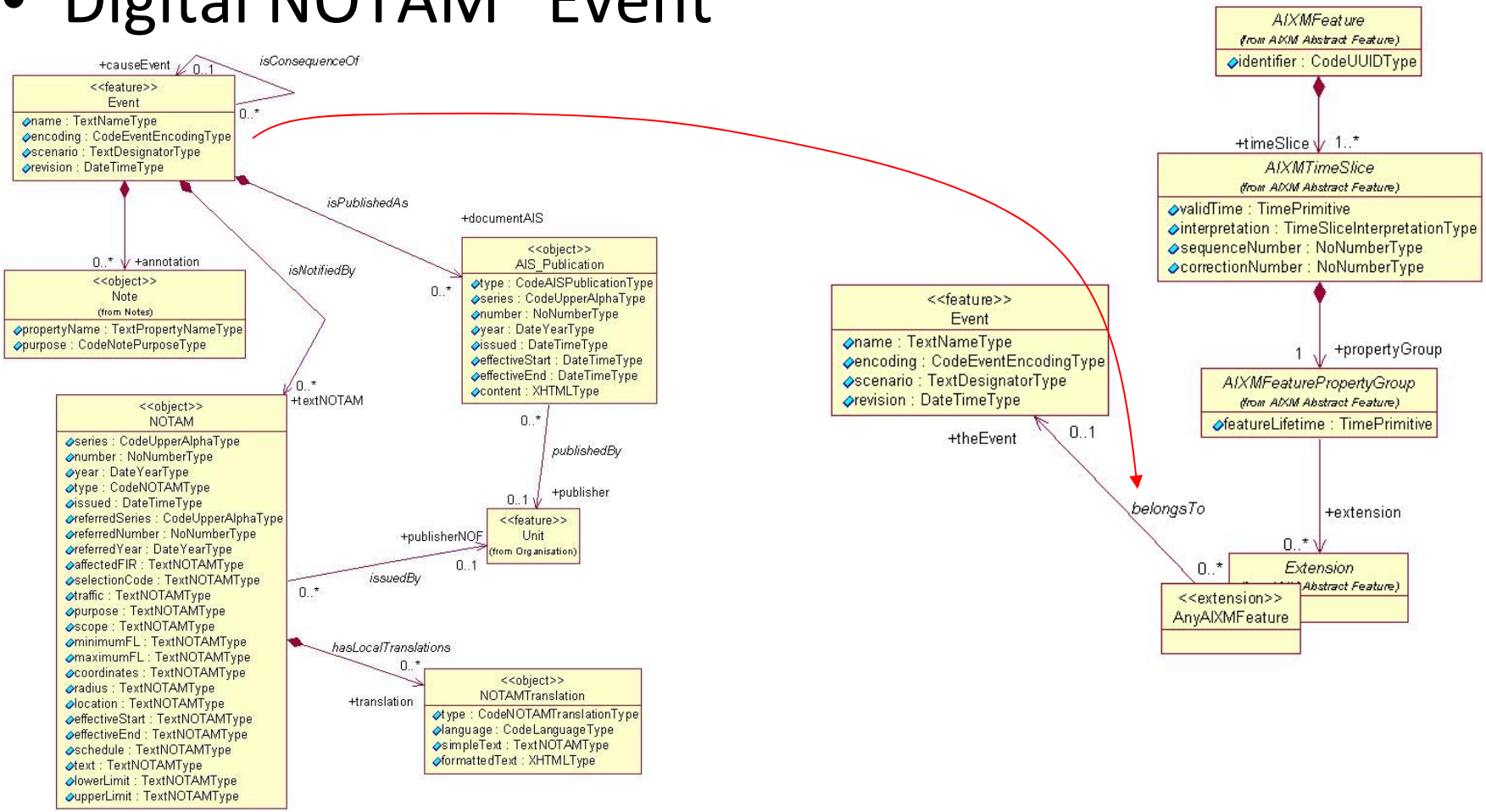
AIXM 5.1 Extensions

Additional information exchanged between selected partners



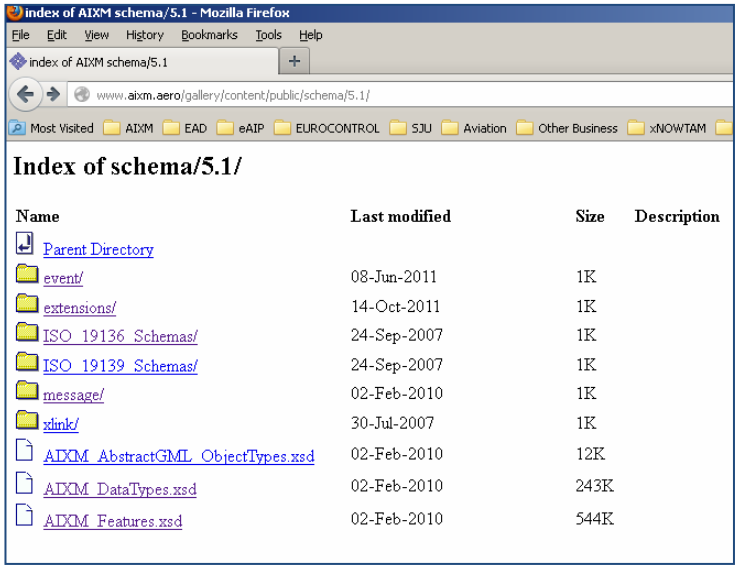
AIXM 5.1 Extensions

- Digital NOTAM “Event”



AIXM 5.1 Public Extensions

- Eurocontrol “Airspace Data Repository”
  - Conditional Routes / Flexible use of Airspace
  - NM/ADR custom “TimeTable”
- Eurocontrol EAD
  - “Slot” management
- FAA Federal NOTAM System
  - US NOTAM specific elements
- MXIA
  - Reverse associations
    - Airport has Runways
    - Route has RouteSegments
    - Etc.



AIXM 5.0/5.1 Extensions

- Do you have another one?
  - Please make it available on www.aixm.aero/wiki
  - Required Documentation
    - UML Model
      - Nice to have: document explaining the need for the extension
    - XML Schema (suggested namespace URI www.aixm.aero/schema/5.1/extensions/...)
    - Example files

ICAO Adoption

- Annex 15 AMDT 37 Proposal

~~3.6.5~~ **3.6 Use of automation**

3.6.1 **~~Recommendation.~~** Automation ~~*enabling digital data exchange should*~~ shall be introduced with the objective of improving the timeliness ~~speed~~, quality, efficiency and cost-effectiveness of aeronautical information services.

3.6.2 Where aeronautical data and aeronautical information are provided in multiple formats, processes shall be implemented to ensure data and information consistency between formats.

3.6.3 In order to meet the data quality requirements, automation shall:

a) enable digital aeronautical data exchange between the parties involved in the data processing chain; and

b) use aeronautical information exchange models and data exchange models designed to be globally interoperable.

3.6.6 **Recommendation.**— *The aeronautical data exchange model used should:*

a) apply a commonly used data encoding format;

b) cover all the classes, attributes, data types and associations of the aeronautical information model detailed in paragraph 3.6.5; and

c) provide an extension mechanism, by which groups of users can extend the properties of existing features and add new features which do not adversely affect global standardization.

3.6.4 **Recommendation.**— *The aeronautical information model used should encompass the aeronautical data and aeronautical information to be exchanged.*

3.6.5 **Recommendation.**— *The aeronautical information model used should:*

a) use the Unified Modelling Language (UML) to describe the aeronautical information features and their properties, associations, and data types;

b) include data value constraints and data verification rules;

c) include provisions for metadata as specified in section 3.4.2; and

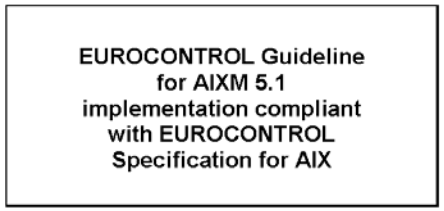
d) include a temporality model to enable capturing the evolution of the properties of an aeronautical information feature during its life cycle.

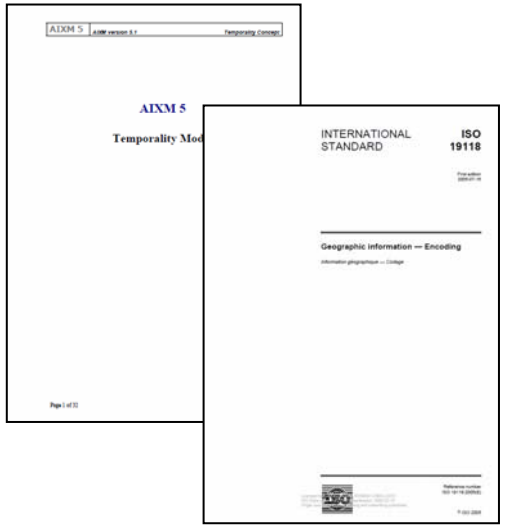
- AIXM as means of compliance
  - More details in AIS Manual (DOC 8126) and later possibly in a PANS-AIM

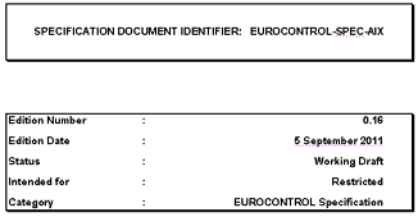
European ADQ Regulation

- 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 for Data Set/Exchange Format – AIXM 5.1
    - AIX Specification in public review

EUROCONTROL
Specification for
Aeronautical Information
Exchange


EUROCONTROL Guideline
for AIXM 5.1
implementation compliant
with EUROCONTROL
Specification for AIX




SPECIFICATION DOCUMENT IDENTIFIER: EUROCONTROL-SPEC-AIX

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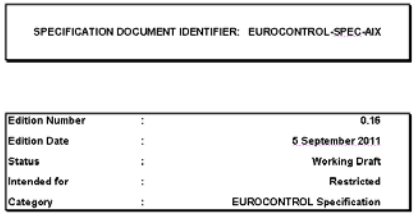
Status	:	Working Draft
Intended for	:	Restricted
Category	:	EUROCONTROL Specification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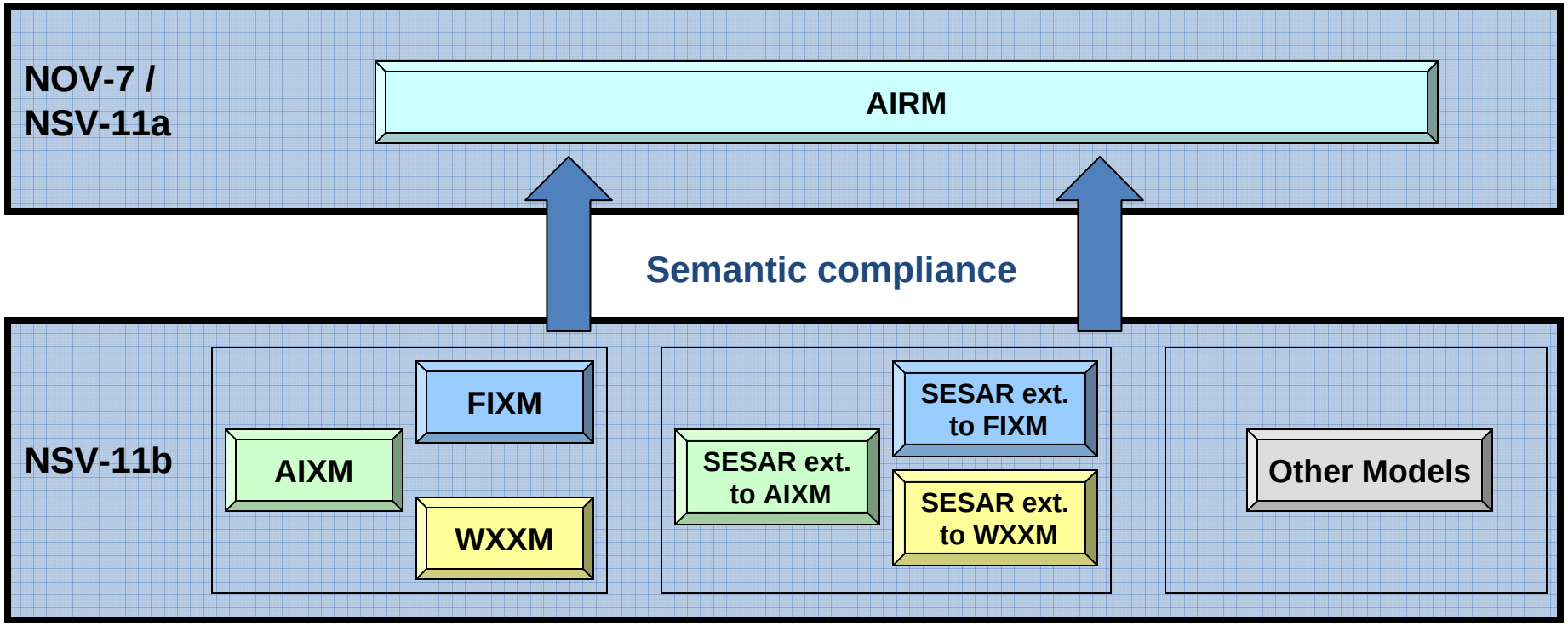
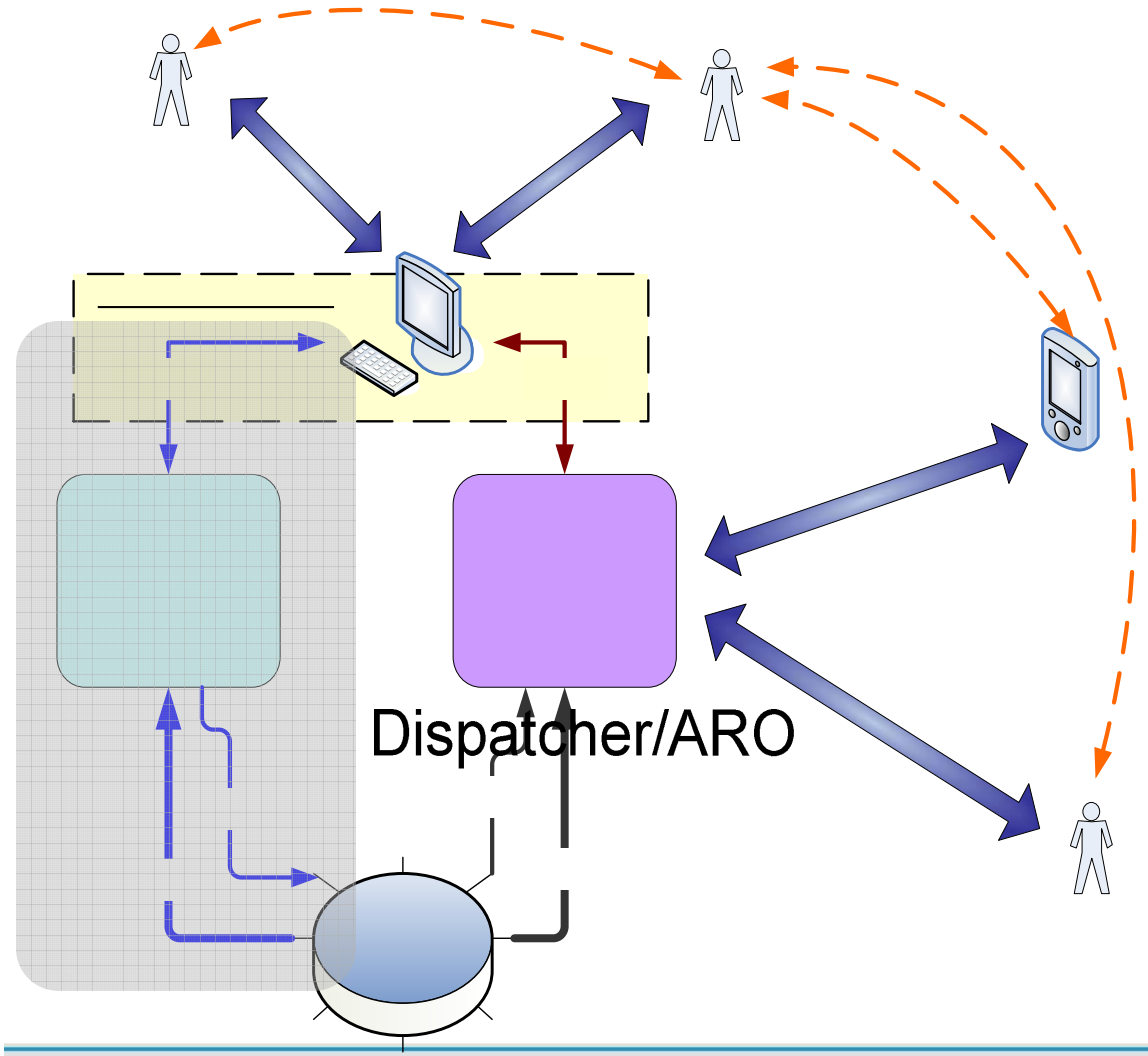
EUROCONTROL

Federal Aviation Administration

AIXM in SESAR



AIXM in SESAR



Digital NOTAM &
Digital Integrated Briefing

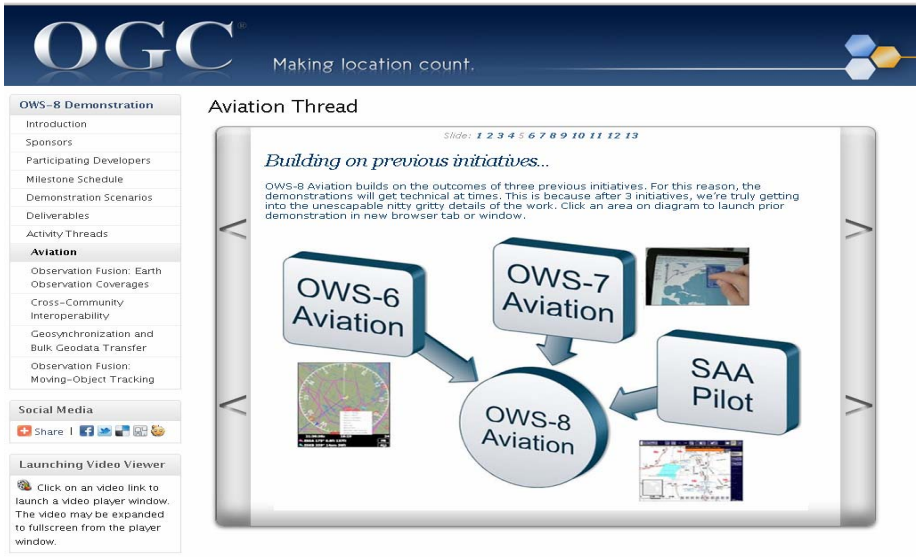
(Project 13.2.2)

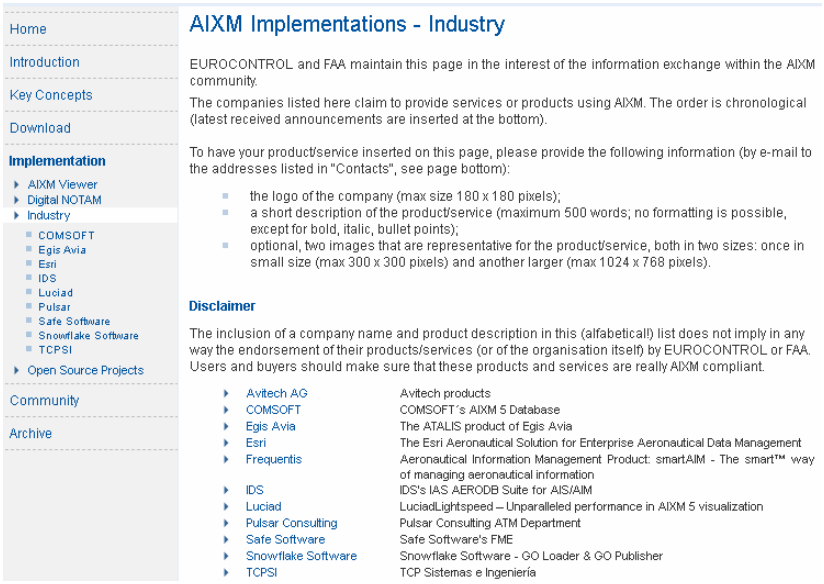
Industry implementations

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

OGC test beds (OWS-9)

Links page on www.aixm.aero





EUROCONTROL

Federal Aviation Administration

Future versions

- Proposed
  - Minor Release AIXM 5.1.1 by end 2012
    - XML Schema improvements/corrections, such as:
      - gml:identifier for <<object>>
      - allow empty AIXM_BasicMessage
      - bug corrections (spelling errors)
    - UML model
      - No changes to classes, attributes, associations
      - Possibly, improvements of definitions
      - Migration from RationalRose (IBM) to EA (Sparx)

Future versions

- Proposed
  - Regular update AIXM 5.2 by end 2013
    - 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

Air Transportation Information Exchange Conference - (featuring AIXM, WXXM and FIXM)

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