Brussels, 19-20 May 2014

Digital NOTAM Workshop

Item 9 - Business Rules and Digital NOTAM Validation

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Digital NOTAM – AIXM / XML data

Is it correct, complete, … safe for intended use?

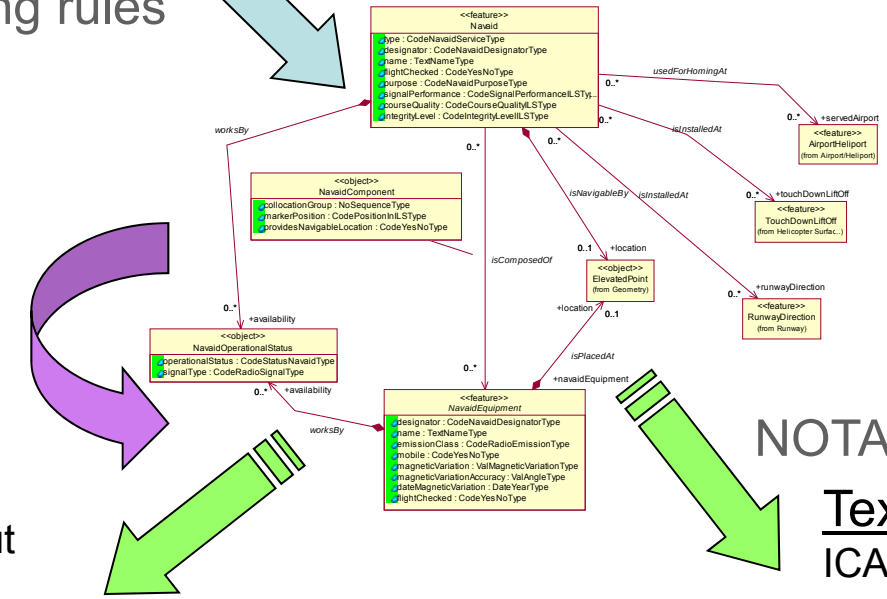
Event Scenario concept

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

Data encoding rules

Data validation 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>
```

NOTAM production rules

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

Rules – data encoding

Identifier	***Data encoding rule***
ER-01	The activation of an airspace shall be encoded as: • a new Event (encoding="DIGITAL", scenario="SAA.ACT", version="2.0"), for which PERMDELTA and subsequent BASELINE TimeSlice shall be created; and • a TimeSlice of type TEMPDELTA for the corresponding Airspace feature, for which the "event:theEvent" property points to the Event instance created above; the TEMPDELTA shall contain one or more AirspaceActivation objects.
ER-02	If the whole airspace becomes active, from floor to ceiling, then the Airspace TEMPDELTA should use the values "FLOOR, uom=OTHER" for lowerLimit and "CEILING, uom=OTHER" for the upperLimit of the AirspaceLayer associated with the AirspaceActivation.
ER-03	Only the following values shalle be used for the AirspaceActivation.status • ACTIVE • IN_USE • INTERMITTENT
ER-04	If the airspace becomes active below its nominal lower limit or above its nominal upper limit (as defined in the Airspace BASELINE), then the Airspace TEMPDELTA TimeSlice shall include both: • the appropriate upper/lower limit values inside the AirspaceLayer associated with the AirspaceActivation, and • the AirspaceGeometryComponents with the modified upper and/or lower limits.
ER-05	If the area activation is limited to a discrete schedule within the overall time period between the "start time" and the "end time", then this shall be encoded using as many as necessary timeInterval/Timesheet properties for the AirspaceActivation of the Airspace TEMPDELTA Timeslice. See the encoding rules for {{Schedules}}.

Event Specification – Appendix – Business Rules

[SAA.ACT] Special Activity Area activation

The following table contains data verification rules applicable to all events that have scenario=SAA.ACT

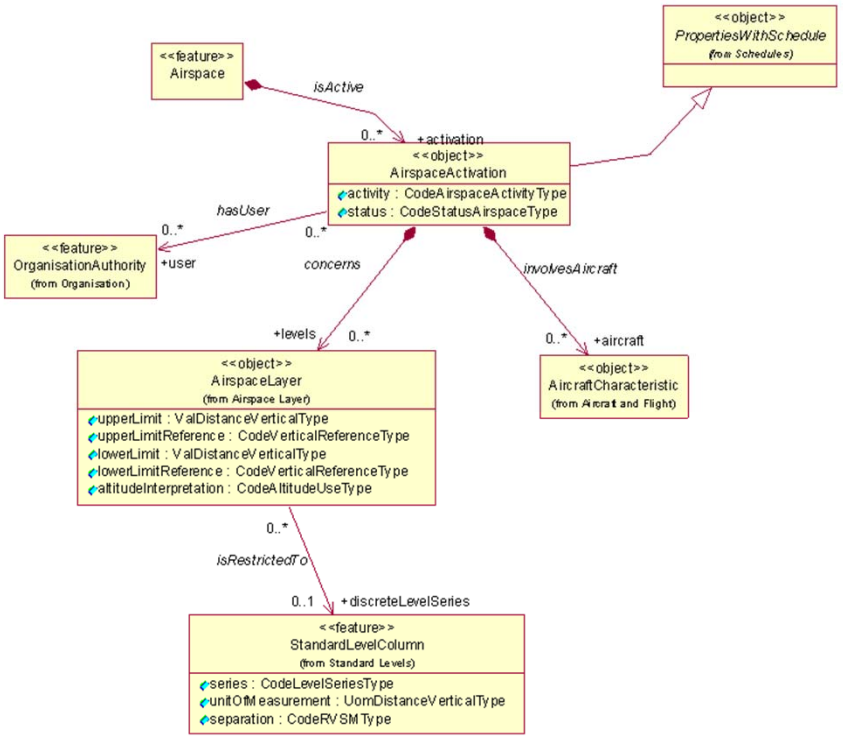
Rule identifier	*Title*	*Description*	*Error level*
	Minimal data requirements	As a minimum, in addition to the AIXM mandatory properties gml:validTime and aixm:interpretation, the Airspace TEMPDELTA TimeSlice shall contain at least aixm:sequenceNumber and one aixm:activation element with at least the aixm:status, aixm:upperLimit, aixm:lowerLimit descendant elements specified (not NIL).	error
	Non-duplication with other Events	There should not exist another Airspace TEMPDELTA with an overlapping (partially or totally) gml:validTime and which also contains aixm:activation elements.	warning
	Airspace type consistent with the scenario	The value of the Airspace BASELINE aixm:type shall be either "P", "R", "D", "TSA", "TRA", "D_OTHER", "W", "PROTECT" (as any other value would be in conflict with the purpose of this scenario).	error

Objective

- Identify to the maximum possible extent the rules that can be used for verifying the data at all key transaction points in the data chain
  - when a Digital NOTAM proposal is **received from a data originator**, in order to assess the completeness/correctness of the data
  - when a Digital NOTAM is **published**, in order to verify that the output complies with the rules for that specific scenario
  - when a Digital NOTAM is **received by a data user**, in order to verify if the data is plausible, coherent and complete for the intended use, before submitting it for automatic processing

AIXM 5.1 – Business Rules concept

- Definition



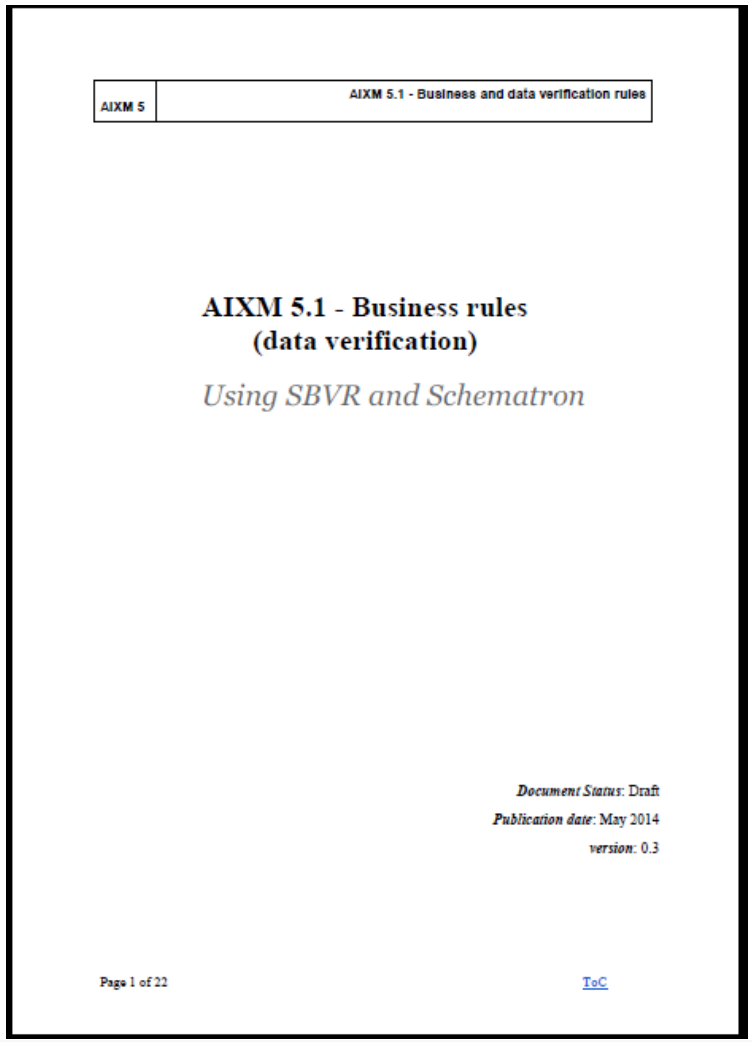
SBVR (on UML)

- Implementation

```
<timeSlice>
  <AirspaceTimeSlice gml:id="AS01_TS01">
    <gml:validTime>
      <gml:TimeInstant gml:id="AS01_TS01_TI01">
        <gml:timePosition>2010-06-12T08:13:00</gml:timePosition>
      </gml:TimeInstant>
    </gml:validTime>
    <aixm:interpretation>SNAPSHOT</aixm:interpretation>
    <aixm:type>R</aixm:type>
    <aixm:designator>R736AB</aixm:designator>
    <aixm:name>TOWNSVILLE AIRSPACE R736AB</aixm:name>
    <geometryComponent>
      <AirspaceGeometryComponent gml:id="APGC01">
        <operation>BASE</operation>
        <operationSequence>1</operationSequence>
        <theAirspaceVolume>
          <AirspaceVolume gml:id="ASV01">
            <upperLimit uom="FL">420</upperLimit>
            <upperLimitReference>MSL</upperLimitReference>
            <lowerLimit uom="FT">0</lowerLimit>
            <lowerLimitReference>SFC</lowerLimitReference>
            <horizontalProjection>
              <Surface gml:id="SURFACE01">
                <gml:patches>
                  <gml:PolygonPatch>
                    <gml:exterior>
                      <gml:LinearRing>
                        <gml:pos>38 -119</gml:pos>
                        <gml:pos>39 -119</gml:pos>
                        <gml:pos>39 -118</gml:pos>
                        <gml:pos>38 -117</gml:pos>
                      </gml:LinearRing>
                    </gml:exterior>
                  </gml:PolygonPatch>
                </gml:patches>
              </Surface>
            </horizontalProjection>
          </AirspaceVolume>
        </theAirspaceVolume>
      </AirspaceGeometryComponent>
    </geometryComponent>
  </AirspaceTimeSlice>
</timeSlice>
```

- **Schematron (80/20)**
- **Java, C♯, …**

AIXM 5.1 – Business Rules document



AIXM 5	AIXM 5.1 - Business and data verification rules

AIXM 5.1 - Business rules (data verification)

Using SBVR and Schematron

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Executive Summary
Introduction
- The need for Business Rules

Rules definition using SBVR
- Introduction
- SBVR Profile for AIXM
  - SBVR concepts, Logical Operations, Quantification, Modality, Additional SBVR keywords, Additional Fact-types
- Methodology

Schematron reference implementation
- Introduction
- Schematron code - technical aspects
  - XPath version, Use of Java extensions, Content of the Excel file, Practical verification of AIXM data sets, Testing

Annex A - License and Disclaimer
Annex B - Examples
Annex C - AIXM Business Rules Profiles
- Minimum air navigation data set profile, etc.

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.
  - http://www.omg.org/spec/SBVR/1.1/PDF

- Example

Free text

"*The geometry of operational airspace of type CTA, UTA and OCA shall be encoded as an aggregation of the corresponding operational SECTORS*"

SBVR

Each **Airspace**.**type** equal-to ('CTA','UTA', 'OCA') shall *have* exactly one **AirspaceGeometryComponent.operation** equal-to 'BASE' and shall not *have* **AirspaceGeometryComponent.operation** equal-to ('INTERS', 'SUBSTR', 'OTHER') and shall *have* each **AirspaceVolume.contributorAirspace.type** equal-to 'SECTOR' and each **AirspaceVolumeDependency.dependency** equal-to 'FULL_GEOMETRY'

SBVR Profile for AIXM

- **NounConcept**
  - Represented by AIXM UML Classes and Properties, meaning that AIXM Class Name, Role Name or Attribute Name may appear as NounConcept
- *Verb-concept* (also known as “fact-type”)
  - Represented by Name of AIXM UML association. Some frequently used fact types such as “*is property of*” or “*has*” do not appear explicitly in the model, they are implicit associations between a class and one of its attributes.
- Name
  - Represents UML Instances, Slots, Enumeration literals, and their assigned Properties. Also CodeList values
- Keyword
  - the words that can be combined with other designations to form statements and definitions: Logical Operations, Quantification, Modality and Additional keywords

SBVR Profile for AIXM - Example

1. Candidate rule: "*Every airport must have a name*"
2. Identify the fact-type in the model
   - "**name** *is-property-of* **AirportHeliport**"
3. Build the rule text around that fact type:
   - add quantification to each noun concept involved;
   - add logical operations, if more conditions are involved;
   - add modality for the fact type.
   - "It is obligatory that exactly one **name** *is-property-of* each **AirportHeliport**"
4. Simplify the text using alternative keywords (if necessary)
   - For example, use "shall" instead of "it is obligatory that"
   - "Each **AirportHeliport** shall *have* exactly one **name**"

SBVR Profile for AIXM

- Examples of other rules
  - Each **Runway** shall *be situated at* exactly one **AirportHeliport**
  - A **Runway** shall not *be situated at* **AirportHeliport** with **type**= 'HP'
  - Each **StandardInstrumentArrival** shall have assigned **designator**
  - Each **TACAN** shall have assigned **channel**
  - Each **Timesheet** shall *have* **endTime** greater-than **startTime**

Digital NOTAM – specific rules

Free text

“Notes contained in TimeSlice(s) associated with a Digital NOTAM Event shall be limited to the character set indicated in the Digital NOTAM Event Specification, Part 1, section ‘Character Set’”

SBVR

Each **Note** that *is-descendant-of* **FeatureTimeslice** that *has* assigned descendant **event:theEvent** shall not *have* assigned **translatedNote.note** using a different character from {'A','B','C','D','E','F','G','H','I','J','K','L','M','N','O','P','Q','R','S','T','U','V','W','X','Y','Z',
'a','b','c','d','e','f','g','h','i','j','k','l','m','n','o','p','q','r','s','t','u','v','w','x','y','z','0','1','2','3','4','5','6','7','8','9','-','?',':','(',')','.',',',''"','=','/','+'}.

Verifying Data with ISO Schematron

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

- There are 6 basic elements in ISO Schematron: assertion, rule, pattern, schema, namespace and phase.

Verifying Data with ISO Schematron

- **<assert>** and **<report>** elements
  - Test attribute
  - Simple declarative sentences in natural language
  - <*assert*> used to tag assertions positively

```
<!-- The assert element matches if test is false -->
<assert test="//designator">
An AirportHeliport shall have a designator.
</assert>
```

- **<rule>** element
  - Used to group assertions
  - Has a context: if the context matches, the assertions are tested

- **<pattern>, <phase>, <schema>:** used to logically group rules

Verifying Data with ISO Schematron

```
<iso:rule
context="//aixm:*[ancestor::aixm:timeSlice[.//event:theEvent]]/aixm:annotat
ion/aixm:Note/aixm:translatedNote/aixm:LinguisticNote/aixm:note">

  <iso:assert test="matches(text(), '^[A-Za-z0-9 \-\?:\(\)\.,=/\+]*$',
'msi')" diagnostics="std_err">[AIXM-5.1_RULE-29FE0]  Each Note that is-
property-of FeatureTimeslice that has assigned descendant event:theEvent
shall not have assigned translatedNote.note using a different character
from {'A','B','C','D','E','F','G','H','I','J','K','L','M','N','O','P','Q',
'R','S','T','U','V','W','X','Y','Z','a','b','c','d','e','f','g','h','i','j'
,'k','l','m','n','o','p','q','r','s','t','u','v','w','x','y','z','0','1','2
','3','4','5','6','7','8','9','-','?',':','(',')',
'.',',',"'",'=','/','+'}.
  </iso:assert>
</iso:rule>
```

Event Specification - Business rules (appendix)

General rules (any scenario)

The following table contains both rules that are applicable to any AIXM feature/TimeSlice and rules that are specific to Digital NOTAM encoding, but which are not specific to a particular scenario. The first column contains the rule identifier from the general AIXM 5.1 Business Rules set, where the definition of the rule is provided in SBVR format and might include Schematron code enabling the direct verification of the rule on an AIXM data set containng Digital NOTAM data.

Rule identifier	***Title***	***Description***	***Error level***
AIXM-5.1_RULE-1A3EC1 AIXM-5.1_RULE-1A3EC2 AIXM-5.1_RULE-1A3EC3 AIXM-5.1_RULE-1A3EC4 AIXM-5.1_RULE-1A3EC5 AIXM-5.1_RULE-1A3EC6 AIXM-5.1_RULE-1A3EC7 AIXM-5.1_RULE-1A3EC8 AIXM-5.1_RULE-1A3EC9 AIXM-5.1_RULE-1A3ECA AIXM-5.1_RULE-1A3ECB AIXM-5.1_RULE-1A3ECC AIXM-5.1_RULE-1A3ECD AIXM-5.1_RULE-1A3ECE	Template - GML Profile restriction	GML elements that are not included in the GML Aviation profile (https://portal.opengeospatial.org/files/?artifact_id=47859) shall not be used in AIXM.	Fatal
more to be added			
AIXM-5.1_RULE-29FE0	NOTAM character set limitation	Notes contained in TimeSlice(s) associated with a Digital NOTAM Event shall be limited to the character set indicated in the Digital NOTAM Event Specification, Part 1, section {{Character Set}}	Warning

Event Specification - Business rules (appendix)

[SAA.NEW] Ad-hoc special activity area - creation

Rule identifier	*Title*	*Description*	*Error level*
	Minimal data requirements	As a minimum, in addition to the AIXM mandatory properties gml:validTime and aixm:interpretation, the Airspace BASELINE TimeSlice shall contain at least aixm:sequenceNumber, aixm:type, aixm:geometryComponent (including aixm:horizontalProjection, aixm:lowerLimit, aixm:lowerLimitReference, aixm:upperLimit, aixm:upperLimitReference) and at least one aixm:activation element with at least the aixm:status descendant element specified (not NIL).	error
	Non-duplication with other Events	There should not exist another Airspace BASELINE with the same aixm:geometryComponent and an overlapping (partially or totally) gml:validTime.	warning
	Area type consistent with scenario	To be consistent with the scenario, only the following types shall be used: P, D, R, TSA, TRA, W, A, D-OTHER, PROTECT, OTHER	error
	Activity consistent with scenario	The value of the aixm:activity (activity taking place) shall not have the values "AD_TFC", "HELI_TFC" "ATS", "PROCEDURE" (as these values are specific to the Ad-hoc ATS Airspace establishment scenario).	error
	PJE not allowed within TMA/CTR	If aixm:type=PJE, then the geometry of the area should not intersect the geometry of an existing Airspace with type "CTR" or "TMA". (*Note that this is an example of*	warning

Schematron?

Conclusion

- Data verification is a critical aspect for the safe deployment of Digital NOTAM applications
- Using the general AIXM 5.1 Business Rules concept
  - SBVR -> rule definition
  - Schematron -> as coding example
- Event Specification appendix
  - Identify all rules that are relevant for Digital NOTAM verification