

*Global Information  
Management*

# Data Validation as a Service

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*Date:*

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Federal Aviation  
Administration



## **AIR TRANSPORTATION INFORMATION EXCHANGE CONFERENCE**

**Global Information Management**

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# Outline

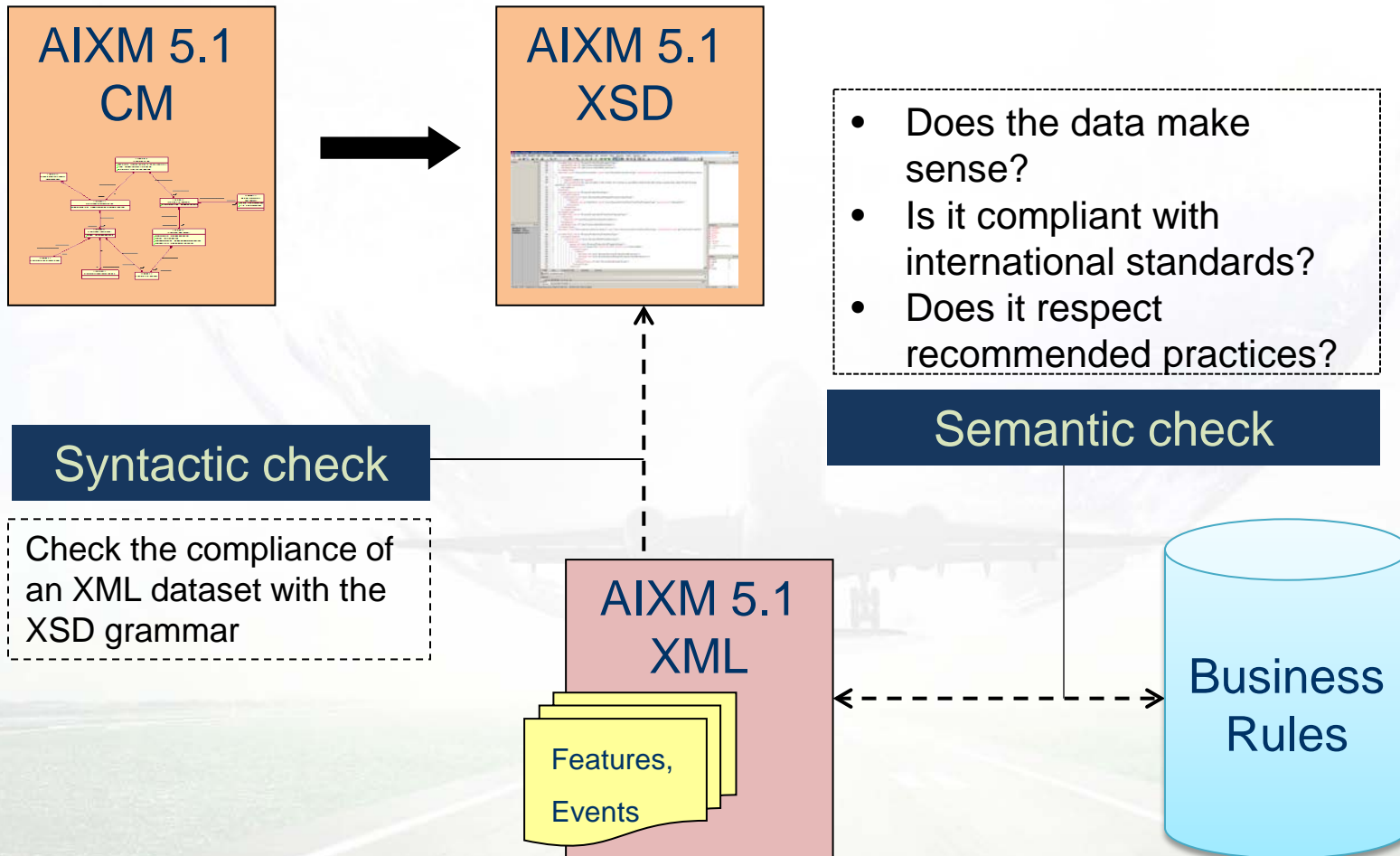
- Introduction
- Business Rules & Validation Preprocessing
- Validation Service Interface & Implementation
- Future Work
- Summary

# INTRODUCTION

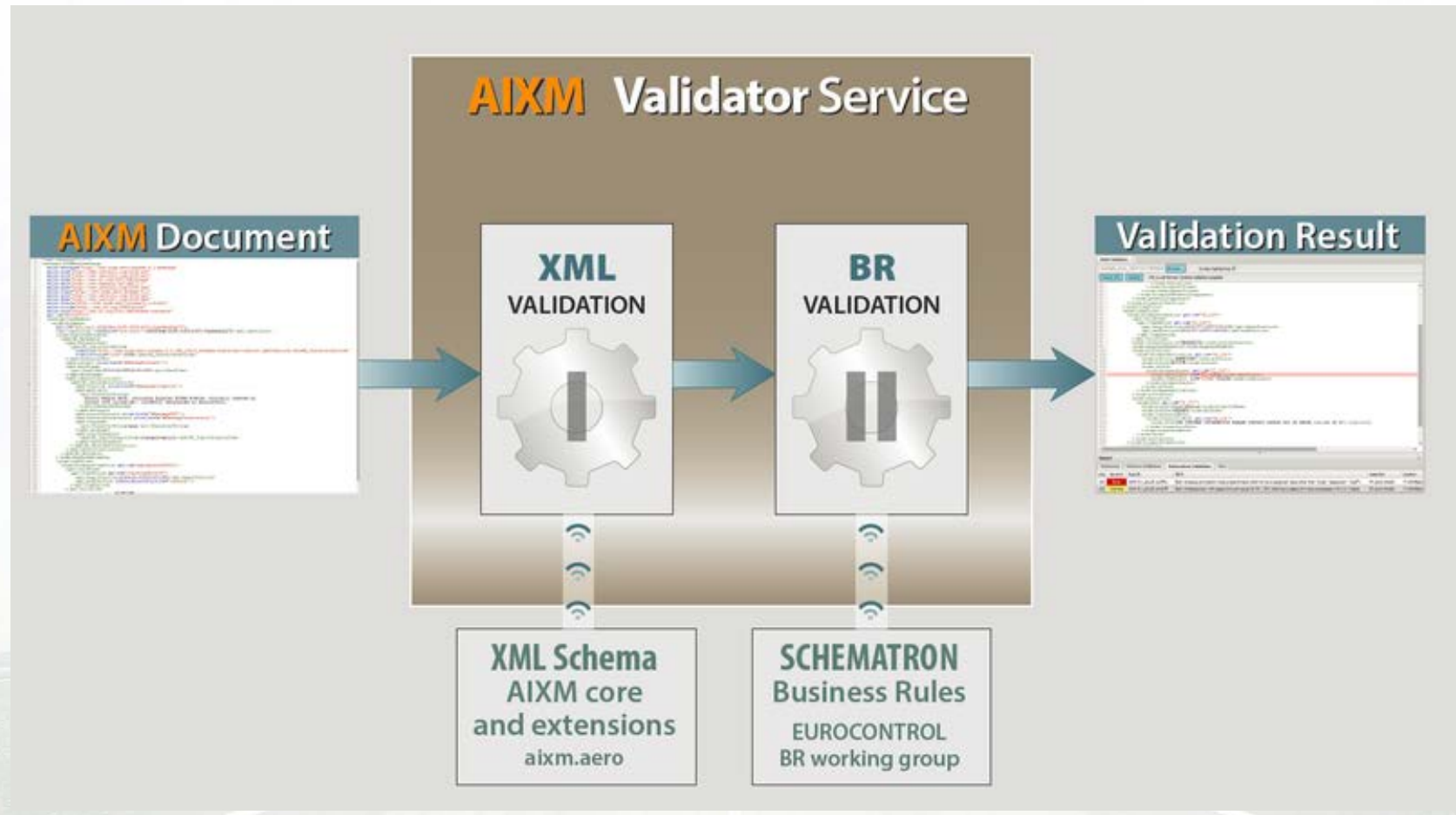
# Validation Basics

- Validation is used to check the structural and logical consistency of aeronautical data, compliance with international standards and fulfillment of best practices
- Subject of validation is AIXM 5.1 data and extensions (Event/D-NOTAM and other EUR and FAA extensions such as eASM, FNSE, MXIA):
  - <http://www.aixm.aero/gallery/content/public/schema/5.1/extensions/index.html>
- Validation against:
  - Structural rules (XML schema)
  - Predefined set of business rules like those specified here: [https://ext.eurocontrol.int/aixmwiki\\_public/bin/view/Main/AIXM\\_Business\\_Rules](https://ext.eurocontrol.int/aixmwiki_public/bin/view/Main/AIXM_Business_Rules)

# AIXM 5.1 Validation



# Validation as Service, Workflow



# Validation Basics 2

- Data validation is important both when data is issued and when data is used
- For static aeronautical data the data validation traditionally takes place at recipient side
- Data validation on own data repository requires local code
- Alternatively, the validation as a service based on concepts of cloud computing and SOA
- Validation service – a SWIM infrastructure service?


# Validation as a Service, Advantages

- Standard SOA pro arguments
- Encapsulation and reuse by both data providers and data users (service reusability)
- Role as reference (authoritative) validator service
- Lower operational, maintenance and development costs


See m-click.aero implementation for an example of remote validation (web) service: <https://swim.m-click.aero/validator/>



# Validation Service Example



## AIXM Schema & Business Rules Validator



Validator | Documentation
Premium Login

Browse...
Demo
Format XML
Syntax highlighting:

Validate
X There are schema issues. X There are rules issues.

#### Validator Details

Line: 40

Severity: Warning

Rule ID: AIXM-5.1\_RULE-3E8

SBVR: Each assigned srsName value shall be equal-to 'urn:ogc:def:crs:EPSG::4326'

Assertion: `.[@srsName='urn:ogc:def:crs:EPSG::4326']`

Location: `/*:AIXMBasicMessage[namespace-uri()='http://www.aixm.aero/schema/5.1/message']`

```

<!-- when this airspace was first created -->
<gml:endPosition/>
</gml:TimePeriod>
</aixm:featureLifetime>
<aixm:type>ISA</aixm:type>
<aixm:designator>EBTSA26A</aixm:designator>
<aixm:name>ISA ARDENNES 01</aixm:name>
<aixm:designatorICAO>NO</aixm:designatorICAO>
<aixm:controlType>MIL</aixm:controlType>
<aixm:geometryComponent>
  <aixm:AirspaceGeometryComponent gml:id="A-c6211807">
    <aixm:theAirspaceVolume>
      <aixm:AirspaceVolume gml:id="A-cd610fd4">
        <aixm:upperLimit uom="FL">999</aixm:upperLimit>
        <aixm:upperLimitReference>STD</aixm:upperLimitR
        <aixm:lowerLimit uom="FL">95</aixm:lowerLimit>
        <aixm:lowerLimitReference>STD</aixm:lowerLimitR
        <aixm:horizontalProjection>
          <aixm:Surface gml:id="VID000004" srsName="urn
            <gml:polygonPatches>
              <gml:PolygonPatch>
                <gml:exterior>
                  <gml:LinearRing>
                    <gml:pos>4.12861111 50.55611111</gm
                    <gml:pos>4.59166667 50.64</gml:pos>
                    <gml:pos>4.84305556 50.58916667</gm
                    <gml:pos>5.71 50.02222222</gml:pos>
                    <gml:pos>5.71 49.79444444</gml:pos>
                    <gml:pos>5.27638889 49.68666667</gm

```

#### Report

Summary | XML Schema | Business Rules | Raw
Hide this rule | Hidden:  | Clear filters

Line	Severity	Rule ID	SBVR	Assertion	Location
40	Warning	AIXM-5.1_RULE-3E8	Each assigned srsName value shall be equal-to 'urn:ogc:def:crs:EPSG::4326'	<code>.[@srsName='ur...</code>	<code>/*:AIXMBasicMe...</code>

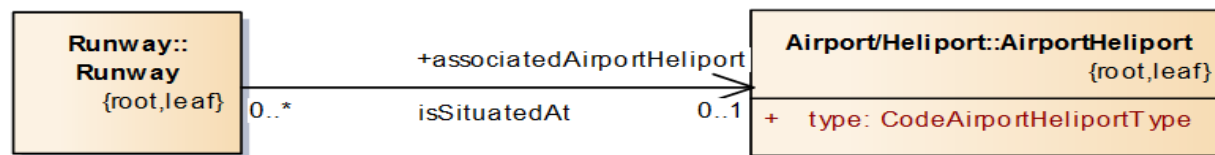
# BUSINESS RULES & VALIDATION PREPROCESSING

# Business Rules

- Document *AIXM 5.1 - Business Rules (data verification)* Rules are use case specific → only common rules should be defined in the schema itself
- Natural language (almost)
- Taxonomy like SVBR
- *Using SBVR and Schematron*: defines SBVR profile for writing AIXM business rules:  
[https://ext.eurocontrol.int/aixmwiki\\_public/bin/view/Main/AIXM\\_Business\\_Rules](https://ext.eurocontrol.int/aixmwiki_public/bin/view/Main/AIXM_Business_Rules)

## Business Rules

- Semantics of Business Vocabulary and Business Rules (SBVR):
  - OMG Standard (<http://www.omg.org/spec/SBVR/1.2/>)
  - Formal and detailed natural language (like) declarative description of business rules
- Example:



AIXM business rule: *it is prohibited that a runway with type equal-to 'RWY' isSituatdAt AirportHeliport with type equal-to 'HP'*

- Business rule specification contains many hundreds rules:  
[https://ext.eurocontrol.int/aixmwiki\\_public/bin/download/Main/AIXM\\_Business\\_Rules/AIXM-5.1-BusinessRules-v.0.4.xlsx](https://ext.eurocontrol.int/aixmwiki_public/bin/download/Main/AIXM_Business_Rules/AIXM-5.1-BusinessRules-v.0.4.xlsx)

# Rules Transformation

## Process

- How to automatically enforce the validation rules (native English, SVBR)?
- Use Schematron for XSLT for service's rule execution engine.
- Generate Schematron for XSLT compatible, equivalent set of rules.

Merging AIXM core and  
extension XML schemas

Loading SBVR constraints

Parsing SBVR constraints  
to First Order Logic

Translate First Order  
Logic to Schematron

# An Example

- **Business rule AIXM-5.1\_RULE-EB5A0:**
  - Each **RunwayDirection.timeSlice** that belongsTo **Event** with scenario equal-to '**RWY.CLS**' and with version equal-to '2.0' shall have exactly one assigned availability value and shall have **availability.ManoeuvringAreaAvailability.operationalStatus** equal-to '**CLOSED**'.
- **XPath within Schematron assertion** (context is aixm:RunwayDirection):
  - every \$x1 in current()/aixm:timeSlice satisfies ((not(for \$c3 in count(for \$x2 in \$x1/\*/aixm:extension/\*/event:theEvent return if (((for \$c1 in count(for \$x3 in //\*[concat('#',@gml:id)=\$x2/@xlink:href]/event:timeSlice/\*/event:scenario return if (\$x3 = 'RWY.CLS') then 1 else ()) return (\$c1 >= 1)) and (for \$c2 in count(for \$x4 in //\*[concat('#',@gml:id)=\$x2/@xlink:href]/event:timeSlice/\*/event:version return if (\$x4 = '2.0') then 1 else ()) return (\$c2 >= 1)))) then 1 else ()) return (\$c3 >= 1)) or ((for \$c4 in count(for \$x5 in \$x1/\*/aixm:availability return if (not(\$x5[@xsi:nil='true'])) then 1 else ()) return (\$c4 = 1)) and (for \$c5 in count(for \$x6 in \$x1/\*/aixm:availability/\*/aixm:operationalStatus return if (\$x6 = 'CLOSED') then 1 else ()) return (\$c5 >= 1))))))

# SBVR-to-Schematron Derivation

- Automated derivation of Schematron code from AIXM business rules:
  - **Saves time and resources** of experts
  - **Prevents errors** that can result from manual creation of Schematron code.
  - Works for rules written against conceptual model of **AIXM** and also of **AIXM extensions**
  - Translation rate: currently > 60% - can be increased (through future work)
  - Implemented in OGC Testbed 11:
    - As extension to ShapeChange (<http://shapechange.net>)
    - Further details available in *OGC Testbed 11 Aviation - Guidance on Using SBVR Engineering Report* (OGC document number 15-024, to be published on <http://www.opengeospatial.org/standards/per>)

# VALIDATION SERVICE INTERFACE & IMPLEMENTATION



# Introduction

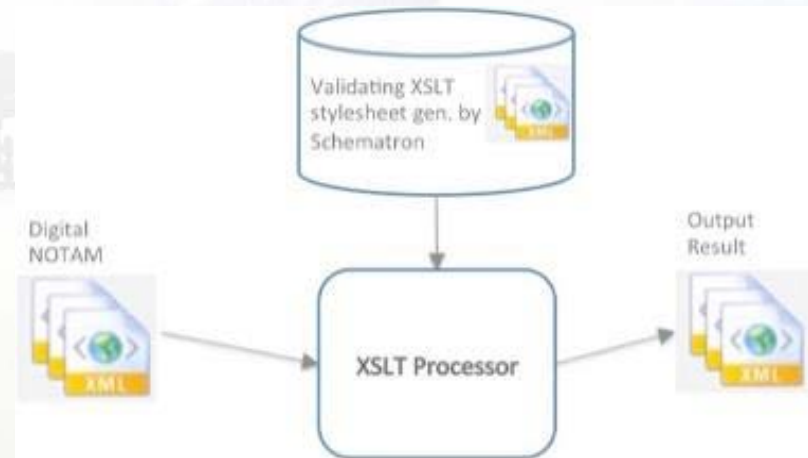
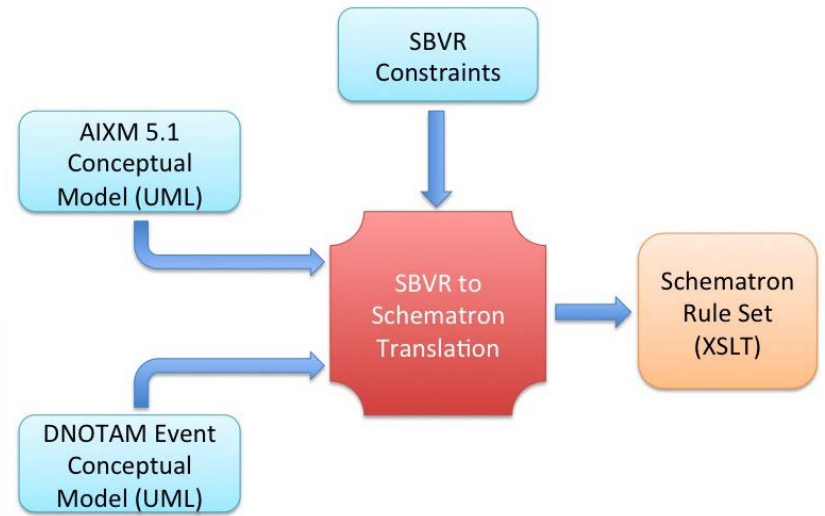
- Validation service:
  - Check AIXM 5.1 documents against set of predefined validation rules
  - Check D-NOTAMs against set of predefined validation rules
- May occur at data source, on client side or anywhere in the processing chain
- Digital NOTAM extension characteristics:
  - Extension to AIXM 5.1 schema
  - New feature type: Event
  - Additional reference “theEvent” for time slices (usually TEMPDELTA) of all feature types
- Further details available in *OGC Testbed 11 Aviation – Digital NOTAM Validation and Enrichment Service* (OGC document number 15-027, to be published on <http://www.opengeospatial.org/standards/per>)

# Service Interface

- OGC WPS 1.0 (Web Processing Service) compatible service endpoint (<http://www.opengeospatial.org/standards/wps> )
- Input
  - Feature collection (AIXM 5.1 entities or D-NOTAM messages)
  - In case of Digital NOTAM, Event feature and associated features if available (RunwayDirection, etc.)
- Output
  - Validation report embedded in AIXM 5.1 feature's time slice metadata elements
  - Validation report encoded using ISO 19115/19139 derived Geographic MetaData extensible markup language (GMD).

# Service Implementation

- Rules Repository
  - Business rules expressed in SBVR (formal, human-readable language)
  - Schematron rules are auto-generated from SBVR constraints
  - Rule repository as a XSLT document Schematron for XSLT rules
- Validation Engine
  - Schematron rules compiled to XSLT Using XPath 2.0 expressions
  - User defined XPath functions for reference resolving and geometries possible
  - WPS 1.0 service, requires well-formed XML input



# Validation Report

## Example, Web Client

Details

Request (XML) Response (XML) Feature (XML) Feature Metadata

**VALID** OGC Testbed-11 DNOTAM Validation, 2015-05-21T11:36:20.197Z

Severity	Rule ID	SBVR
(none)		

**INVALID** OGC Testbed-11 DNOTAM Validation, 2015-05-21T11:33:49.111Z

Severity	Rule ID	SBVR
1 Error	AIXM-5.1_RULE-TB11-1	Each Event.timeSlice.EventTimeSlice.scenario shall not have assigned value other than ('SAA.ACT', 'ATSA.ACT', 'SAA.NEW', 'ATSA.NEW', 'RTE.CLS', 'RTE.OPN', 'AD.CLS', 'RWY.CLS', 'OBS.NEW', 'NAV.UNS', 'OBLT.UNS', 'THR.CHG', 'RWE.CLS', 'ALS.UNS', 'VAS.UNS', 'TWY.CLS', 'RWL.UNS', 'TWL.UNS', 'TWY.LIM', 'OTHER')

# Future Work

- Testing
- Complete AIMM 5.1 schema merging
- Continue working on SBVR rules
- WPS 2.0?
- Validation Service Interface improvements

# Summary

- Validation as a Service work was performed within the OGC Testbed-11.
- The concept was developed in accordance with SOA, which promotes reusability.
- Automated derivation of Schematron for XSLT code from AIXM 5.1 and D-NOTAM validation business rules (60%)
- Validation as a Service via standard OGC services such as the OGC WPS 1.0 (Web Processing Service) compatible service endpoint <http://www.opengeospatial.org/standards/wps> )
- Validation report encoded using ISO 19115/19139 derived Geographic MetaData extensible markup language (GMD).

**Thank you for your attention.  
Any questions?**



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