AIXM

The Aeronautical Information Exchange Model

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Agenda

- The AIXM Conceptual Model
- AIXM XML Schema
- Overview of AIXM Files
- AIXM Instance data
- Demo

General Scheme

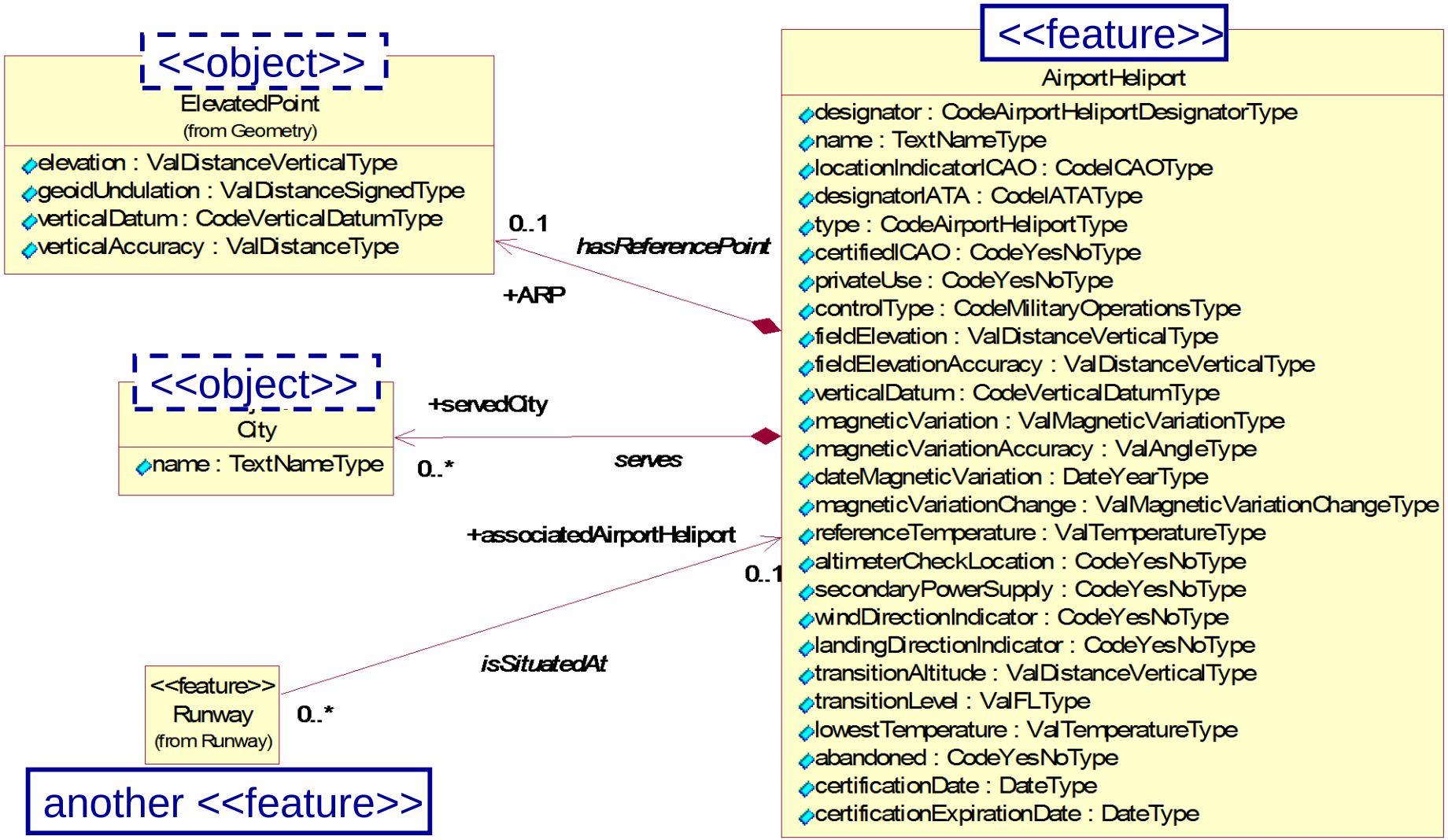
- AIXM is modelled using UML
  - UML features are GML objects
  - UML objects are GML Objects
- UML model generates XSD files which act as schema definitions of the AIXM data
- The AIXM data is defined as XML files
  - GML data
- Software (Java or XSLT) is used to transform the XML data to HTML to be viewed by a browser

Source : AIXM is GML

The AIXM Conceptual Model

- Models
  - Important features
  - Properties (Attributes and associations)
  - Business rules
- Can be used as the basis for the design of AIM (Aeronautical Information Management) database
- Designed using UML

Example – AIXM Conceptual Model



Source : AIXM 5.1 Seminar

AIXM XSD Files

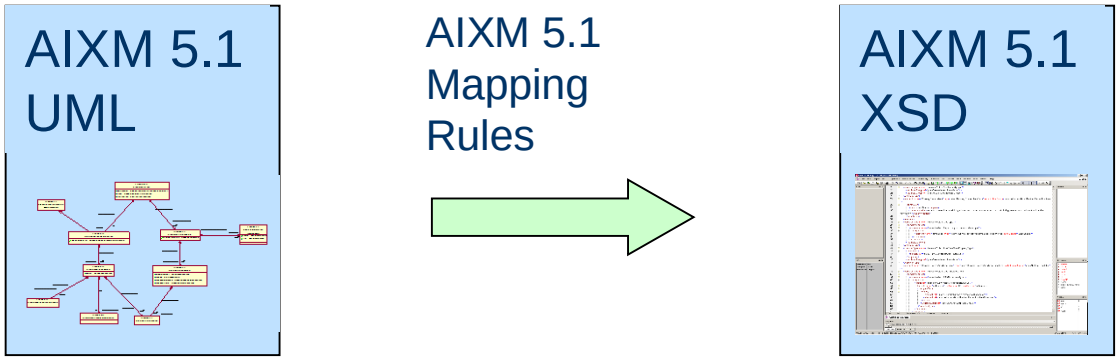
- GML consists of 28 core XSD Schemas

- AIXM uses:
  - Xlinks.xsd (as it is)
  - A compilation of GML definitions from the other GML core schemas in two files:
    - AIXM-AbstractGML-ObjectTypes.xsd
    - Gml4aixm.xsd

Overview of AIXM files

- The file **AIXM_AbstractGML_ObjectTypes.xsd**
  - References the ISO19139 Metadata Schema
  - Defines the base AIXM Feature Constructs
    - AbstractAIXMFeatureType / AbstractAIXMFeature
    - AbstractAIXMTimesliceType / AbstractAIXMTimeslice
- The file AIXM_DataTypes.xsd contains the mapping of the AIXM datatypes
- The file AIXM_Features.xsd contains the mapping of the AIXM features

Overview of AIXM files



- AIXM 5.1 Mapping rules explain how to translate the AIXM 5.1 UML model into an XML grammar based on a subset of the Geography Markup Language (GML 3.2)

- Mapping rules are defined for:
  - AIXM Datatypes
  - AIXM Features

Source : UML to XML Schema Mapping

Special aspects

- Namespaces
  - aixm:, gml:, etc.
- Object/property model
- Mapping Rules
  - Datatypes
  - Features
- Extensibility
- Temporality

Namespaces

- **aixm:**
  - version 5.1
    - xmlns:aixm="http://www.aixm.aero/schema/5.1"
- **gml:**
  - <import namespace="http://www.opengis.net/gml/3.2" schemaLocation="./ISO_19136_Schemas/gml.xsd"/>
- **xlink:**
  - <import namespace="http://www.w3.org/1999/xlink" schemaLocation="./xlink/xlinks.xsd"/>

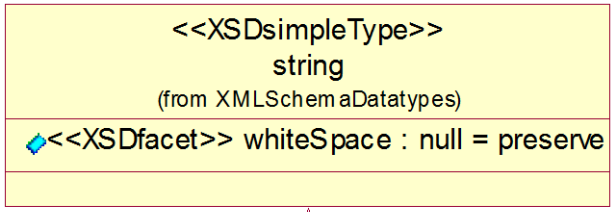
Object/property model

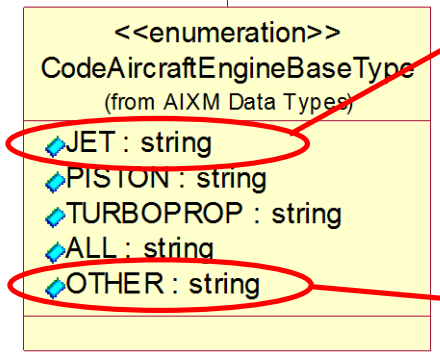
- No GML object may be the immediate child of a GML object – no element may be both a GML object and a GML property

- An association between two features (or a feature and an object) is implemented over a property of the feature, e.g.
  - <AirportHeliport> <!--feature -->
  - <hasReferencePoint> <!--property -->
  - <ElevatedPoint> <!--object -->

AIXM 5.1 Mapping Rules - Datatypes

- Mapping <<enumeration>>

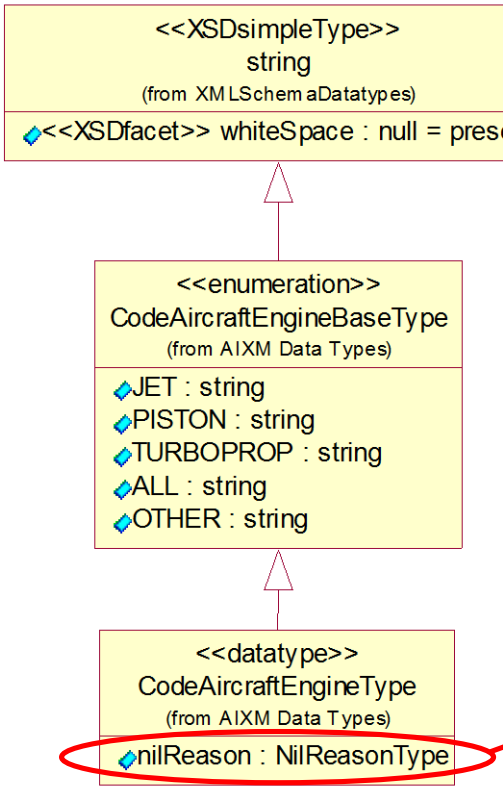





```
<simpleType name="CodeAircraftEngineBaseType">
  <union>
    <simpleType>
      <restriction base="xsd:string">
        <enumeration value="JET">
          <annotation>
            <documentation/>
          </annotation>
        </enumeration>
        <enumeration value="PISTON"/>
        <enumeration value="TURBOPROP"/>
        <enumeration value="ALL"/>
      </restriction>
    </simpleType>
    <simpleType>
      <restriction base="string">
        <pattern value="OTHER:\w{2,58}"/>
      </restriction>
    </simpleType>
  </union>
</simpleType>
```

Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - nilReason




```
<simpleType name="CodeAircraftEngineBaseType">
  <union>
    <simpleType>
      <restriction base="xsd:string">
        <enumeration value="JET">
        ……..
      </restriction>
    </simpleType>
    <simpleType>
      <restriction base="string">
        <pattern value="OTHER:\w{2,58}"/>
      </restriction>
    </simpleType>
  </union>
</simpleType>
```

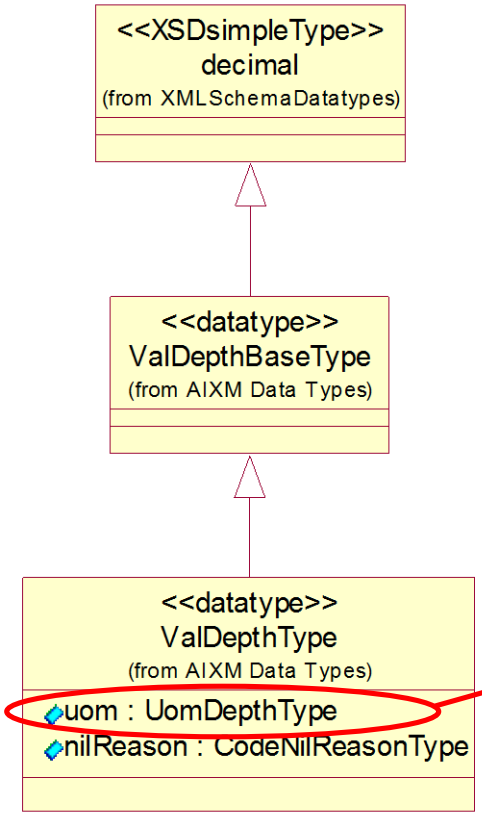
```
<complexType name="CodeAircraftEngineType">
  <simpleContent>
    <extension base="aixm:CodeAircraftEngineBaseType">
      <attribute name="nilReason“ type="aixm:NilReasonType"/>
    </extension>
  </simpleContent>
</complexType>
```

- Most of AIXM 5.1 Data Types define a **nilReason**, used to indicate **the reason for a null value**.

Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - UOM

- Mapping Units of Measurements




```
<simpleType name="ValDepthBaseType">
   <restriction base="xsd:decimal">
   </restriction>
</simpleType>
```

```
<complexType name="ValDepthType">
   <simpleContent>
      <extension base="aixm:ValDepthBaseType">
         <attribute name="nilReason" type="aixm:NilReasonType"/>
         <attribute name="uom" type="aixm:UomDepthType" use="required"/>
      </extension>
   </simpleContent>
</complexType>
```

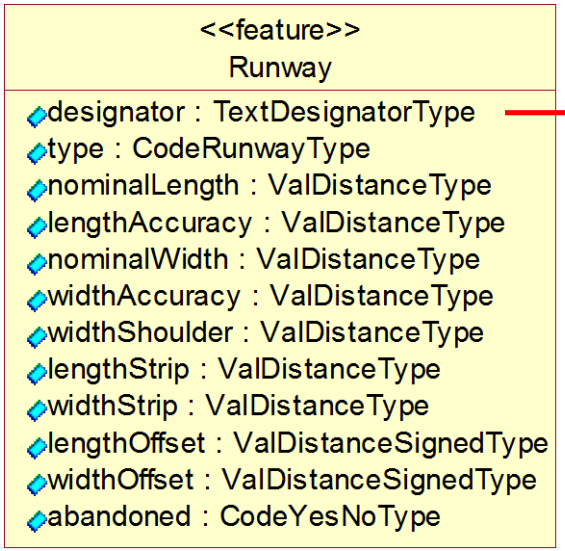
Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - Features

- For each AIXM Feature in the UML, the following XML schema entities are created:
  - *Feature*PropertyType
  - *Feature*
  - *Feature*Type
  - *Feature*TimeSlicePropertyType
  - *Feature*TimeSlice
  - *Feature*TimeSliceType
  - *Feature*PropertyGroup

- AIXM objects are encoded as GML objects. The mapping rules for Objects are the same as the rules for Features except that
  - Object do not exist outside of a feature
  - TimeSlice types and elements are not created

AIXM 5.1 Mapping Rules - Features



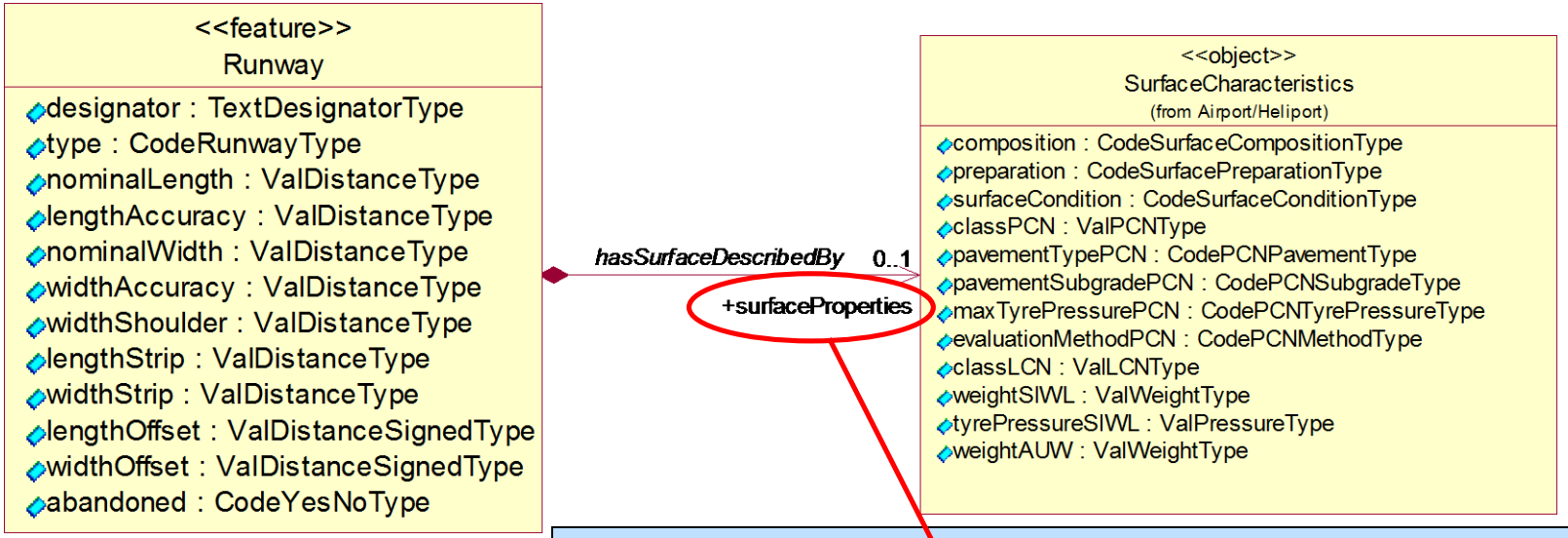

```
<group name="RunwayPropertyGroup">
  <sequence>
    <element name="designator“ type="aixm:TextDesignatorType" nillable="true"
minOccurs="0">
      <annotation>
        <documentation>The full textual designator of the runway, used to uniquely identify it at an
            aerodrome/heliport which has more than one.
            E.g. 09/27, 02R/20L, RWY 1.
        </documentation>
      </annotation>
    </element>
    <element name="type" type="aixm:CodeRunwayType" nillable="true"
minOccurs="0">
    [……….]
  </sequence>
</group>
```

*Runway*PropertyType
Runway
*Runway*Type
*Runway*TimeSlicePropertyType
*Runway*TimeSlice
*Runway*TimeSliceType
***Runway*PropertyGroup**

✓ *UML properties are mapped into FeaturePropertyGroup*

Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - Features

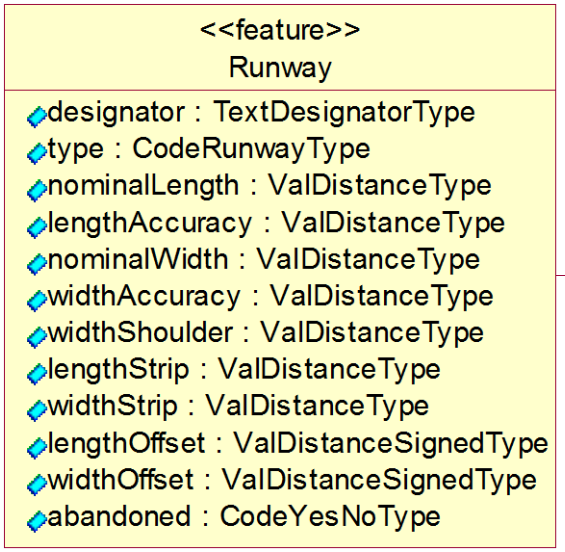


*Runway*PropertyType
Runway
*Runway*Type
*Runway*TimeSlicePropertyType
*Runway*TimeSlice
*Runway*TimeSliceType
***Runway*PropertyGroup**

```
<group name="RunwayPropertyGroup">
  <sequence>
    <element name="designator" nillable="true" minOccurs="0">
    [……]
    <element name="surfaceProperties" nillable="true" minOccurs="0">
      <complexType>
        <complexContent>
          <extension base="aixm:SurfaceCharacteristicsPropertyType">
            <attribute name="nilReason" type="gml:NilReasonEnumeration"/>
          </extension>
        </complexContent>
      </complexType>
    </element>
    [……]
```

Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - Features



✓ *UML properties are mapped into FeaturePropertyGroup*

*Runway*PropertyType
Runway
*Runway*Type
*Runway*TimeSlicePropertyType
*Runway*TimeSlice
*Runway*TimeSliceType
***Runway*PropertyGroup**

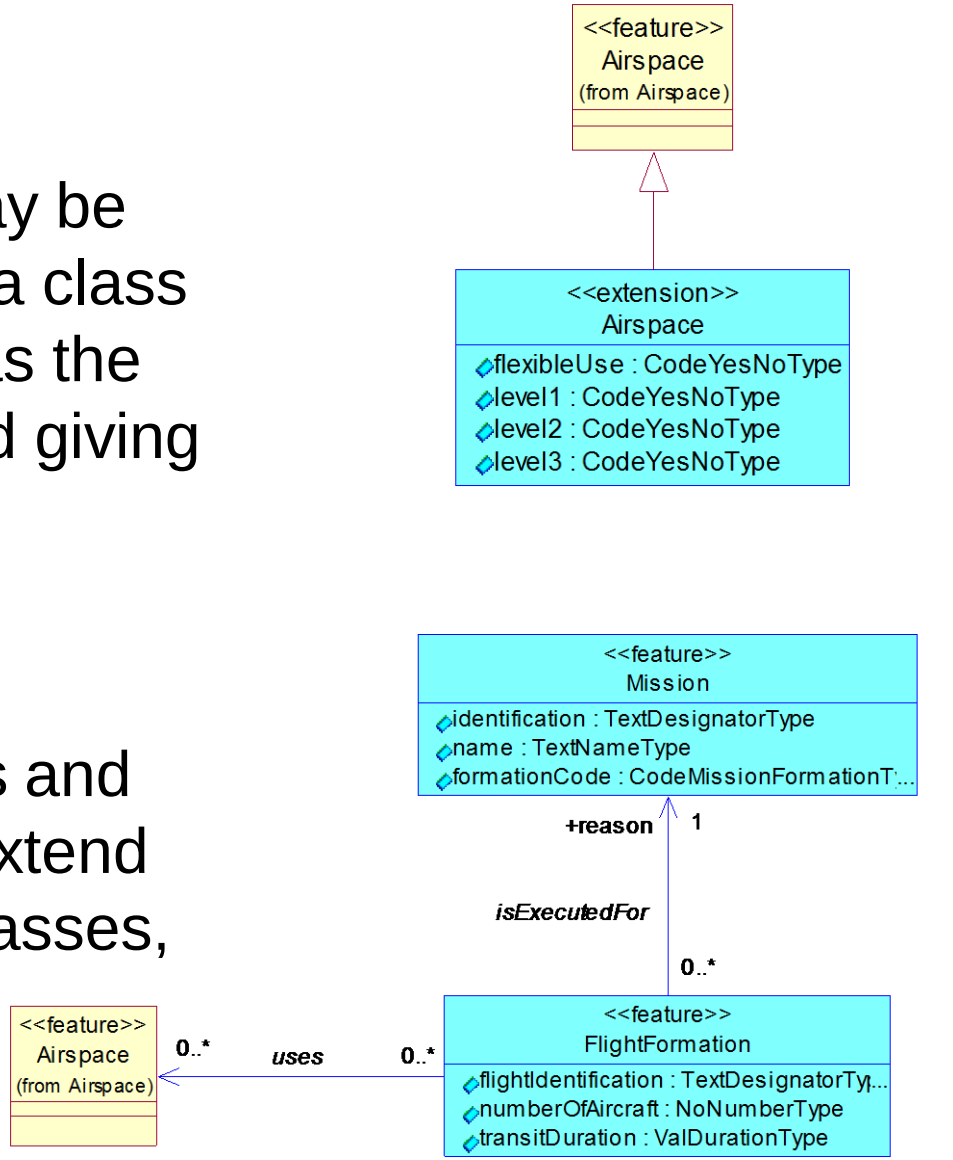
```
<group name="RunwayPropertyGroup">
   <sequence>
      <element name="designator" type="aixm:TextDesignatorType" nillable="true"
minOccurs="0">
      [……]
      <element name="type" type="aixm:CodeRunwayType" nillable="true"
minOccurs="0">
      [……]
      <element name="associatedAirportHeliport"
type="aixm:AirportHeliportPropertyType" nillable="true" minOccurs="0">
      [……]
   </sequence>
</group>
```

Source : UML to XML Schema Mapping

Extensibility

- A feature or object may be extended by creating a class with the same name as the core AIXM feature and giving it a stereotype <<extension>>.

- New classes (features and objects), that do not extend existing AIXM Core classes, can also be created.



Source : UML to XML Schema Mapping

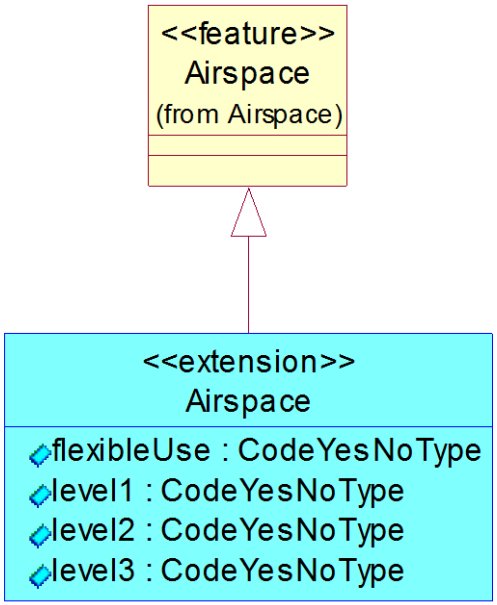
AIXM 5.1 Mapping Rules - Extension

- AIXM_Features.xsd is defined in such a way that multiple extensions can be included in the core *Feature*TimesliceType

```
<complexType name="AirspaceTimeSliceType">
  <complexContent>
    <extension base="aixm:AbstractAIXMTimeSliceType">
      <sequence>
        <group ref="aixm:AirspacePropertyGroup"/>
          <element name="extension" minOccurs="0" maxOccurs="unbounded">
            <complexType>
              <sequence>
                <element ref="aixm:AbstractAirspaceExtension"/>
                [……..]
```

- Features with the stereotype of <<extension>> generates three related elements for that class.
  - *Feature*ExtensionPropertyGroup
  - *Feature*ExtensionType
  - *Feature*Extension

AIXM 5.1 Mapping Rules - Extension

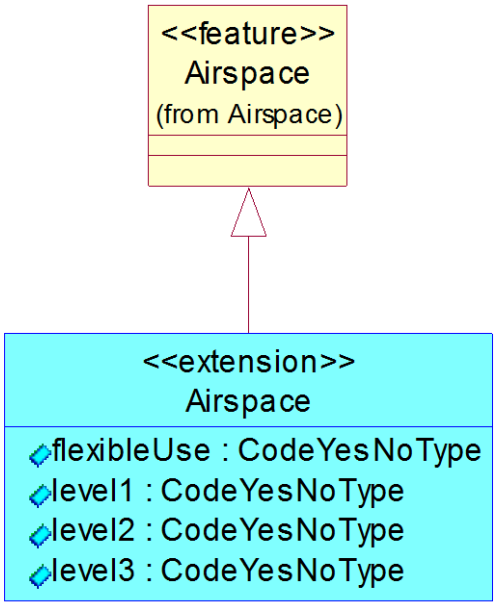



```
<group name="AirspaceExtensionPropertyGroup">
   <sequence>
      <element name="flexibleUse“ type=“CodeYesNoType” nillable="true"
minOccurs="0">
      [……….]
      <element name="level1“ type=“CodeYesNoType” nillable="true"
minOccurs="0">
      [……….]
   </sequence>
</group>
```

*Airspace*Extension
*Airspace*ExtensionType
***Airspace*ExtensionProperty Group**

Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - Extension



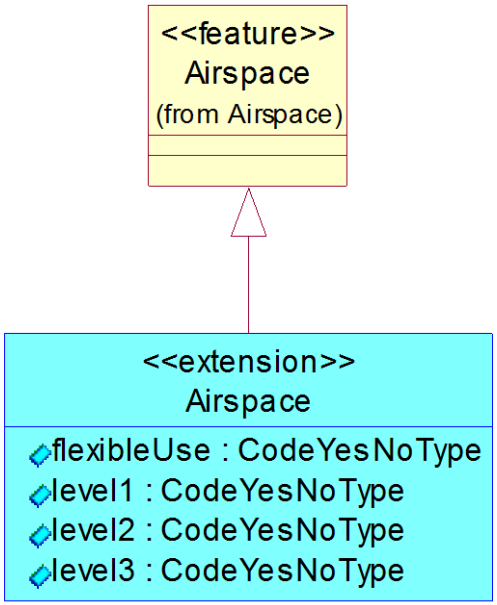

```
<complexType name="AirspaceExtensionType">
   <complexContent>
      <extension base="aixm:AbstractExtensionType">
         <sequence>
            <group ref="easm:AirspaceExtensionPropertyGroup"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

*Airspace*Extension
***Airspace*ExtensionType**
*Airspace*ExtensionPropertyGroup

✓*A relationship is created with an abstract XML element that acts as the root for all extensions.*

Source : UML to XML Schema Mapping

AIXM 5.1 Mapping Rules - Extension



<element name="**AirspaceExtension**" type="easm:AirspaceExtensionType“
substitutionGroup="aixm:AbstractAirspaceExtension"/>

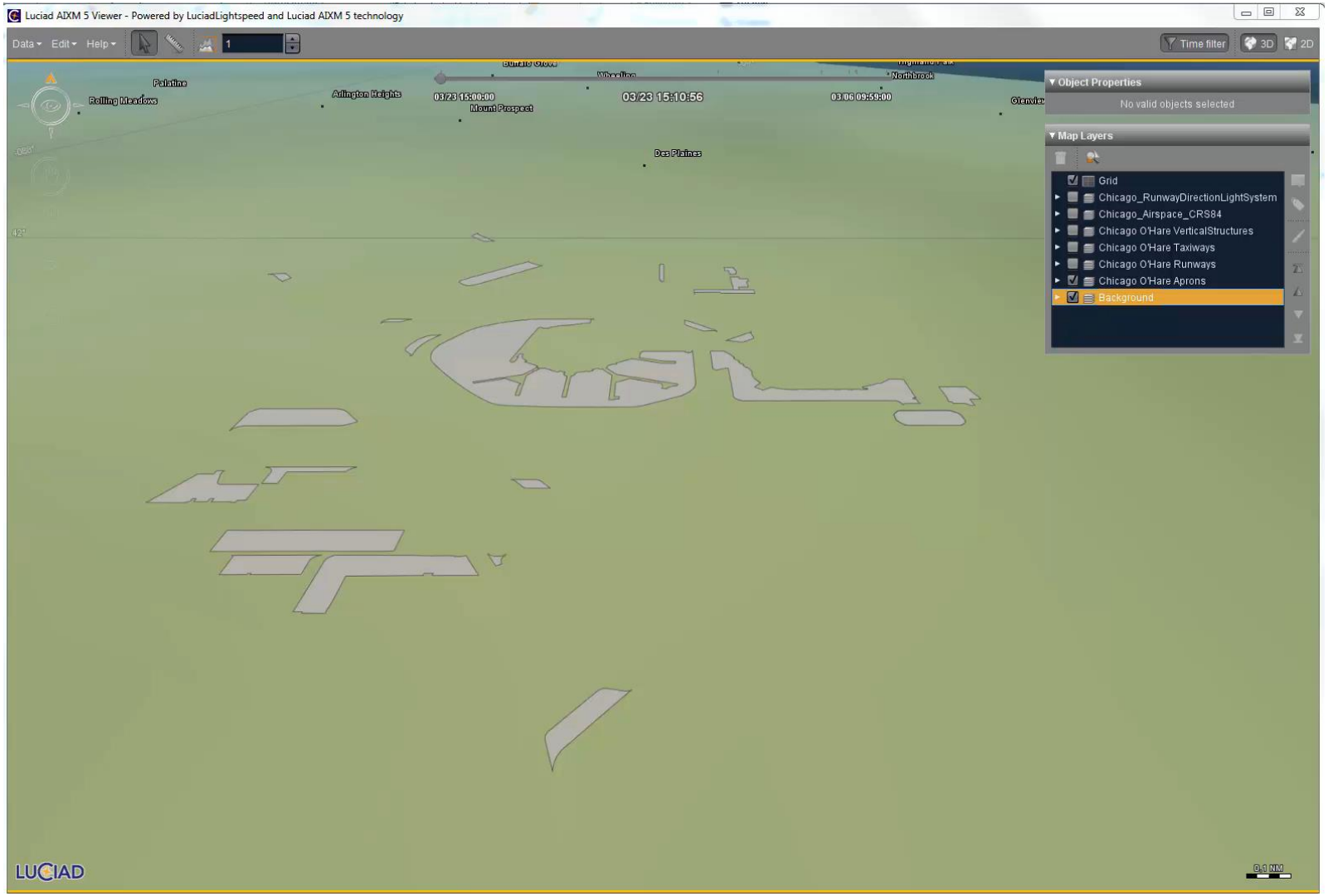
***Airspace*Extension**
*Airspace*ExtensionType
*Airspace*ExtensionPropertyGroup

Source : UML to XML Schema Mapping

AIXM Instance Data


```
<?xml version='1.0' encoding='UTF-8'?>
<message:AIXMBasicMessage xmlns:message="http://www.aixm.aero/schema/5.1/message" xmlns:gts="http://www.isotc211.org/2005/gts" xmlns:gco="http://www.isotc211.org/2005/gco" xmlns:smXML="http://www.isotc211.org/smXML" xmlns:aixm="http://www.aixm.aero/schema/5.1" xmlns:xsi="
http://www.w3.org/2001/XMLSchema-instance"  xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:gss="http://www.isotc211.org/2005/gss" xmlns:gsr="http://www.isotc211.org/2005/gsr" xmlns:scXML="http://www.isotc211.org/scXML"
 xmlns:iso19115="http://www.isotc211.org/2005/gmd" xsi:schemaLocation="http://www.isotc211.org/2005/gts iso/19139/gts/gts.xsd http://www.isotc211.org/2005/gco iso/19139/gco/gco.xsd http://www.w3.org/2001/XMLSchema http://www.w3.org/2001/XMLSchema.xsd http://www.isotc211.org/2005/gss iso/19139/gss/gss.xsd
http://www.isotc211.org/2005/gsr iso/19139/gsr/gsr.xsd http://www.isotc211.org/2005/gmd iso/19139/gmd/gmd.xsd " gml:id="MD01">
  <gml:identifier codeSpace="http://www.faa.gov/NASR">KORD</gml:identifier>
  <message:hasMember>
    <aixm:VerticalStructure gml:id="VPS0">
      <gml:identifier>VPS0</gml:identifier>
      <aixm:timeSlice>
        <aixm:VerticalStructureTimeSlice gml:id="TS0">
          <gml:validTime>
            <gml:TimePeriod gml:id="TSP0">
              <gml:beginPosition>2008-03-23T14:00:00</gml:beginPosition>
              <gml:endPosition indeterminatePosition="unknown"/>
            </gml:TimePeriod>
          </gml:validTime>
          <aixm:interpretation>BASELINE</aixm:interpretation>
          <aixm:sequenceNumber>1</aixm:sequenceNumber>
          <aixm:type>Terminal Building</aixm:type>
          <aixm:part>
            <aixm:VerticalStructurePart>
              <aixm:verticalExtent uom="FT">56.99176340607403</aixm:verticalExtent>
              <aixm:horizontalProjection_surfaceExtent>
                <aixm:ElevatedSurface srsName="urn:ogc:def:crs:EPSG::4269" gml:id="b9826ec1">
                  <gml:patches>
                    <gml:PolygonPatch>
                      <gml:exterior>
                        <gml:LinearRing>
                          <gml:posList>41.9771976092916 -87.9104037282193 41.977212710899 -87.9105002446219 41.9774387599395 -87.9104489893068 41.977427249251 -87.9103434618094 41.9776839599702 -87.9102933135768 41.9776991536129 -87.9103852633764 41.9779389221052 -87.9103299334949 41.9779237284834
                            -87.9102379836953 41.9781737175689 -87.9101830219434 41.9781888191554 -87.9102795838346 41.9784081465242 -87.9102234713075 41.978396175731 -87.9101407777723 41.9792286437224 -87.9099423100675 41.9792437452251 -87.9100388264702 41.9794800148037 -87.9099879401825 41.9794615064017
                            -87.9098913007708 41.9797115874807 -87.9098317724159 41.9797266891509 -87.9099282888185 41.9799628666104 -87.9098819700318 41.9799512639586 -87.9097810091374 41.9802047519369 -87.9097216037917 41.9802165386594 -87.90981343148 41.9804562153048 -87.9097626682016 41.9804411134671
                            -87.9096666150901 41.9807870468139 -87.9095872310941 41.9808860296237 -87.9095816624602 41.9809399872976 -87.9096110293271 41.9809799492329 -87.909658172365 41.9810026008l7 -87.9097180401064 41.9810082180722 -87.9097780147172 41.9810003001843 -87.9098325697308 41.9809788464835
                            -87.9098820661046 41.9809473564905 -87.9099220611428 41.9808990164069 -87.9099523070313 41.9808339180167 -87.9099682389629 41.9795221889373 -87.9102636665723 41.9795480650249 -87.9105022441942 41.9788184470031 -87.9106724323121 41.9788447830999 -87.910888176919 41.9784305287018
                            -87.9109737715444 41.9784006935866 -87.9107624714292 41.9782398350476 -87.9107932282098 41.9782068691392 -87.9105681052764 41.976847260153 -87.9108709448614 41.9767757161056 -87.9108683634647 41.9767286643494 -87.9108346760132 41.9766986469222 -87.9108016018118 41.9766725884388
                            -87.9107412510015 41.9766600654334 -87.910685957933 41.9766714824234 -87.9106269593256 41.9766861221582 -87.9105772160355 41.9767212030792 -87.9105282108004 41.9767626375383 -87.9105022854966 41.9768072027907 -87.910490183011 41.9771976092916 -87.9104037282193</gml:posList>
                        </gml:LinearRing>
                      </gml:exterior>
                    </gml:PolygonPatch>
                  </gml:patches>
                  <aixm:elevation uom="FT">743.008236593926</aixm:elevation>
                </aixm:ElevatedSurface>
              </aixm:horizontalProjection_surfaceExtent>
            </aixm:VerticalStructurePart>
          </aixm:part>
        </aixm:VerticalStructureTimeSlice>
      </aixm:timeSlice>
    </aixm:VerticalStructure>
  </message:hasMember>
```

Demo – Luciad AIXM5 Viewer



References

- Aeronautical Information Exchange Model (AIXM), AIXM 5 UML to XML Schema Mapping, February 2010, www.aixm.aero
- Aeronautical Information Exchange Model (AIXM), AIXM 5 AIXM is GML, October 2007, www.aixm.aero
- AIXM 5.1 Seminar, December 2012, http://www.aixm.aero/public/standard_page/archive.html