

Aeronautical Information Exchange Model (AIXM)

Integrating Aerodrome Mapping Data into AICM/AIXM

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1 Scope

1.1 Objective

The purpose of this document is to present a proposal for enhancing the AICM model to incorporate the AMDB data content requirements. This is done in the context of AIXM version 5 and is primarily based on the ED-99A-AICM gap analysis and its review by EUROCONTROL.

1.2 Background

AIXM, which stands for Aeronautical Information Exchange Model, was developed by EUROCONTROL as a data exchange specification based on Aeronautical Information Conceptual Model (AICM). The two models have been primarily developed and implemented as part of the European AIS database (EAD) program and contains hundreds of features, properties and relationships to represent aeronautical data. These models are primarily based on ICAO requirements for international aeronautical data exchange (Annex 15 to the ICAO Convention) and on industry standards such as ARINC 424.

Since 2003, the United States has been working with EUROCONTROL to extend AIXM to fully support international data exchange of information critical to air navigation. The United States/EUROCONTROL efforts will culminate in the release of AIXM version 5. AIXM version 5 will provide a system independent, international data exchange standard for aeronautical data. As part of these efforts, the AIXM data standard is being refactored to support a wider range of applications and aviation requirements by including ISO geospatial standards, temporality and improved data contents models for airports, procedures and obstacles. Incorporating the Aerodrome Mapping Database (AMDB), which describes the geospatial layout of facilities and equipment and Aerodromes is part of this effort. AMDB requirements are specified in RTCA DO-272,276 and EUROCAE ED-99. The AICM model is extended to include AMDB components based on the suggestions outlined in the gap analyses, which reviewed both the AIXM 4.5 and AMDB models. This document implements the recommended changes using a UML model.

1.3 References

1. ED-99A (Do 272/ED99A) – AICM Gap Analysis, AIXM 5 Proposal. First Edition, 2005-10-23.
2. AIXM 5 Modeling Conventions. First Edition, 2006-06-22.
3. Instructions and Comments, email communication from Porosnicu Eduard (eduard.porosnicu@eurocontrol.int) to Brett Brunk (brett.brunk@faa.gov) on 05-03-2006.
4. User requirements for Aerodrome Mapping Information. RTCA/DO-272A, 07-01-2005.

2 Implementation

This section describes the details of integrating AMDB data content model into version 5 of the AIXM model. The “Data Modeling Conventions for AIXM 5” document is used as the source for all the modeling conventions used in the UML. The goal as laid out in the gap analyses is to integrate the AMDB data content model into AIXM rather than include it. This is achieved by leaving the logical structure of AIXM intact when all the features and attributes of AMDB are handled through different entities and attributes. In cases where they are not, necessary alterations or additions of new entities are made to the model. To enhance traceability and to easily identify the changes, all the AMDB related components are included in a separate package called *AMDB-GML-ObjectTypes*. Similarly, all the new data types added to support the integration is included under a package called *AMDB-DataTypes*. The integration of the different components of the AMDB model are presented in a tabular form describing how they are represented in AMDB and AIXM 4.5 respectively and finally how it is implemented in AIXM 5. Also, the discussion on different components follows the order presented in the gap analyses to make it easy for comparison between the two documents. The implementation section details the addition of new data types, new classes and modification to an existing class to represent the AMDB data content model. If an existing data type is used to represent the attribute, it is only shown in the UML model. Also existing associations are unchanged and are represented as is. Finally, the UML model, developed using Rational Rose is illustrated under each respective section showing the different features, its attributes and the relationships.

2.1 Geometry

Geometry is an integral part of aeronautical data. There are some key differences in how they are represented between AMDB and AIXM 4.5. AMDB uses a set of (GIS) features with their attributes to describe the geometry of an airport. In version 5 of the AIXM model, geometry properties will be standardized based on the ISO19107 spatial schema standard. Within the model, geometry of each feature type is expressed by referencing an existing global ISO19107 element of the appropriate type (Point, Curve and Surface).

2.2 Runway Class

2.2.1 Runway Elements

AMDB	A runway element consists of one or more polygons not defined as other portions of the runway class. Runway elements are associated with AerodromeHelicopter class.
AIXM	No equivalent as runway is described as a single unit (Runway class) and not divided into smaller parts.
Implementation	<p>A new feature class called RunwayElement is added along with a new data type called elementType to describe the different elements. RunwayElement is associated with the AerodromeHelicopter class through an existing association it has with Runway class.</p> <p>New Datatype: elementType enumeration (NORMAL, INTERSECTION, DISPLACED,</p>

SHOULDER)	
	<p>New Class: RunwayElement</p> <p>Stereotype: Feature</p> <p>Attributes:</p> <ul style="list-style-type: none"> - type - length - width - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - surfaceDescribedBy/describingSurface of with SurfaceCharacteristics - having/beingElement with Runways

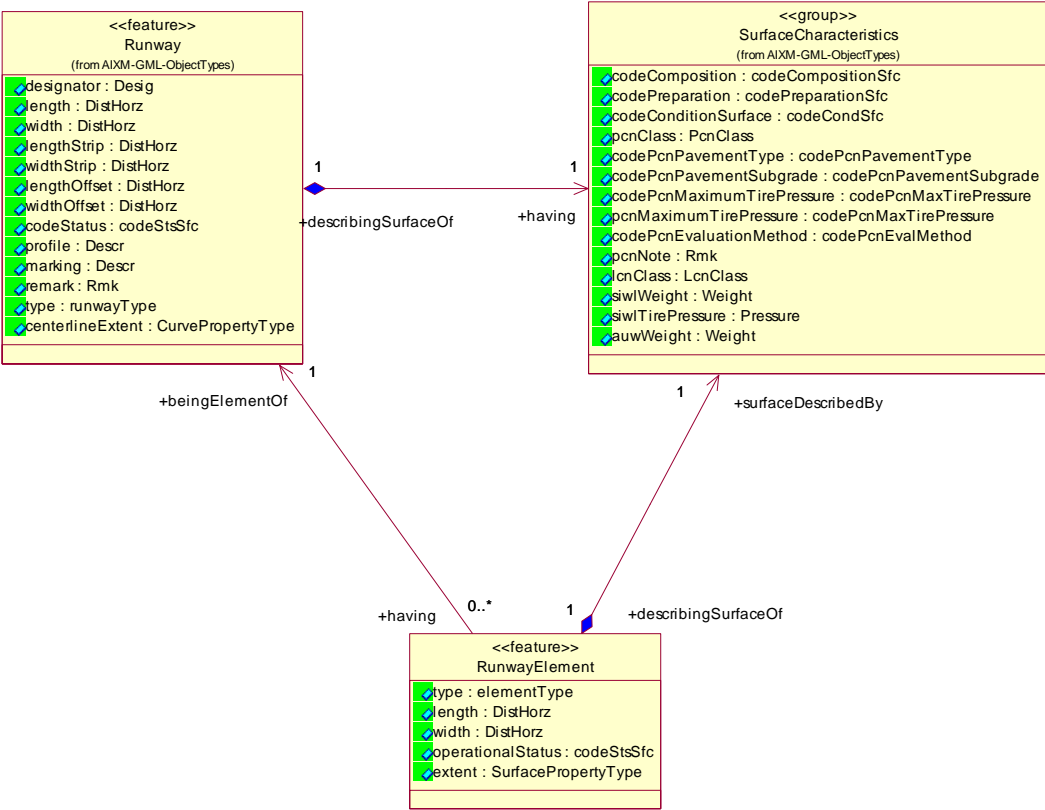


Figure 1: RunwayElement class with its attributes and associations.

2.2.2 Runway Intersections

AMDB	Common area of intersecting runways. Defined using a polygon and is related to the AerodromeHeliport class.
AIXM	No exact equivalent available, as runway in AICM is defined as a whole unit.
Implementation	Represented using the newly added RunwayElement class with "INTERSECTION" value for elementType datatype.

2.2.3 Runway Thresholds

AMDB	Runway threshold is described as the beginning of the portion of the runway that is available for landing and represented as a point. Defined as a point and related to both AerodromeHeliport class and Threshold class.
AIXM	Except the touchdown slope (tdzslope), the remaining attributes of the runway threshold are represented in the RunwayDirection, Runway, RunwayCenterLinePoint and RunwayDirectionDeclDist classes.
Implementation	Modified RunwayDirection class by adding new attribute slopeTDZ. Modified Class: RunwayDirection Attributes: slopeTDZ



Figure 2: RunwayDirection class showing the newly added slopeTDZ attribute

2.2.4 Runway Markings

AMDB	Runway markings are defined as a symbol or group of symbols displayed on the surface of the runway in order to convey aeronautical information. Defined using a polygon and is related to both AerodromeHeliport and Runway classes.
AIXM	No equivalent, except for the description attribute in the Runway Class
Implementation	<p>A new object class RunwayMarking added.</p> <p>New Class: RunwayMarking</p> <p>Stereotype: Feature</p> <p>Attributes:</p> <ul style="list-style-type: none"> - description - extent <p>Associations:</p> <ul style="list-style-type: none"> - having/beingMarkingOn with Runway

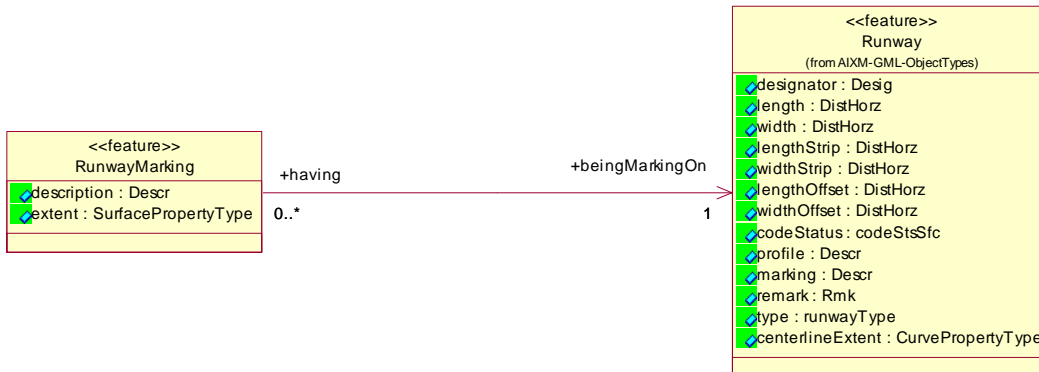


Figure 3: RunwayMarking class along with its attributes and association.

2.2.5 Painted Centerlines

AMDB	Continuous line along the painted line in the centre of a runway connecting the two thresholds. Defined using a line and is related to both AerodromeHeliport and Runway classes.
AIXM	No exact equivalent available
Implementation	Geometry reference is added to the Runway class to describe this property.



Figure 4: Runway class showing the newly added centerlineExtent geometry reference

2.2.6 Arresting Gear Locations

AMDB	Location of the arresting gear cable across the runway. Defined using line geometry and related to both AerodromeHeliport and Threshold.
AIXM	Arresting devices are described only using a description (descriptionArrestingDevice) attribute in RunwayDirection class. RunwayDirection class is equivalent to entity called Threshold in AMDB.
Implementation	<p>New feature class called ArrestingGear with attributes of description, status and geometric reference is added.</p> <p>New Class: ArrestingGear Stereotype: Feature Attributes:</p> <ul style="list-style-type: none"> - description - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - isArrestingGearDeviceFor/having with RunwayDirection class

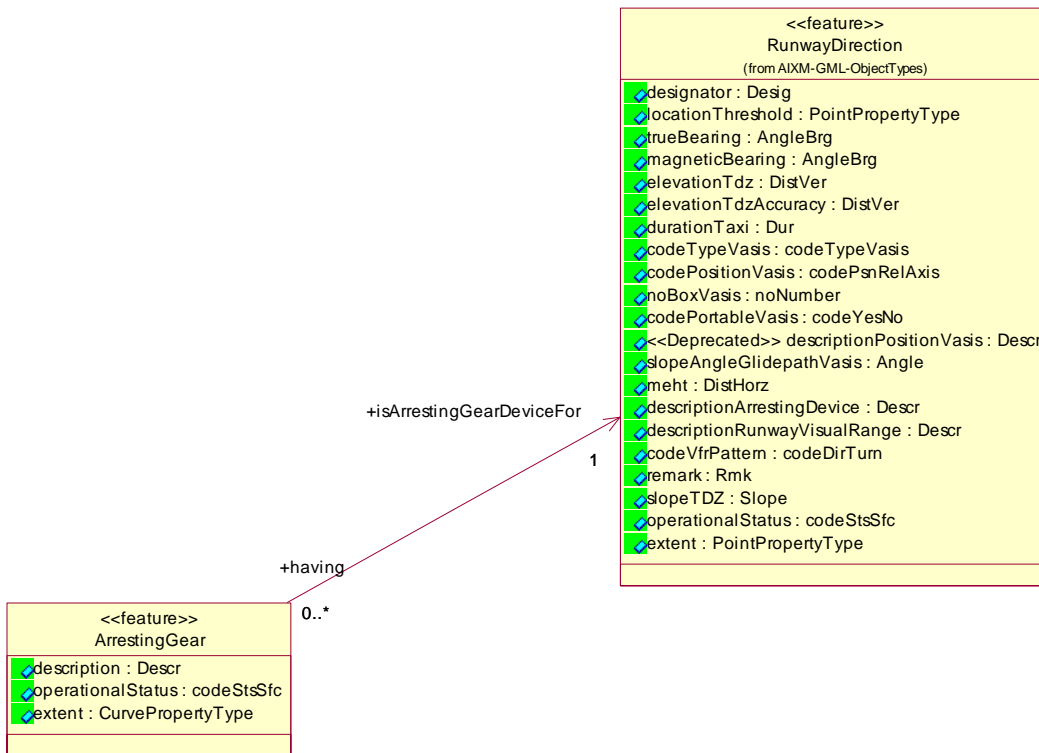


Figure 5: ArrestingGear class with its features and association to RunwayDirection

2.2.7 Runway Shoulders

AMDB	Defined as an area adjacent to the edge of a runway pavement that functions as a transition between pavement and the adjacent surface. Defined using a polygon and related to both AerodromeHeliport and Runway classes.
AIXM	No equivalent available
Implementation	As status and surface characteristics are the only two attributes required, it is modelled by using the newly added class RunwayElement and using a value of "SHOULDER" in the elementType datatype.

2.2.8 Stopways

AMDB	Defined as a rectangular area on the ground at the end of the takeoff, available for an aircraft to be stopped in case the takeoff is abandoned. Defined using polygon geometry and is associated with both Aerodrome/Heliport and Threshold classes.
AIXM	Represented using Stopways class. RunwayDirection, which is equivalent to Threshold class in AMDB is associated with the Stopways class and is also associated with AerodromeHeliport class through Runway class.
Implementation	The only modification done to the existing model is to add a geometric reference to the Stopway class to describe the geometry.

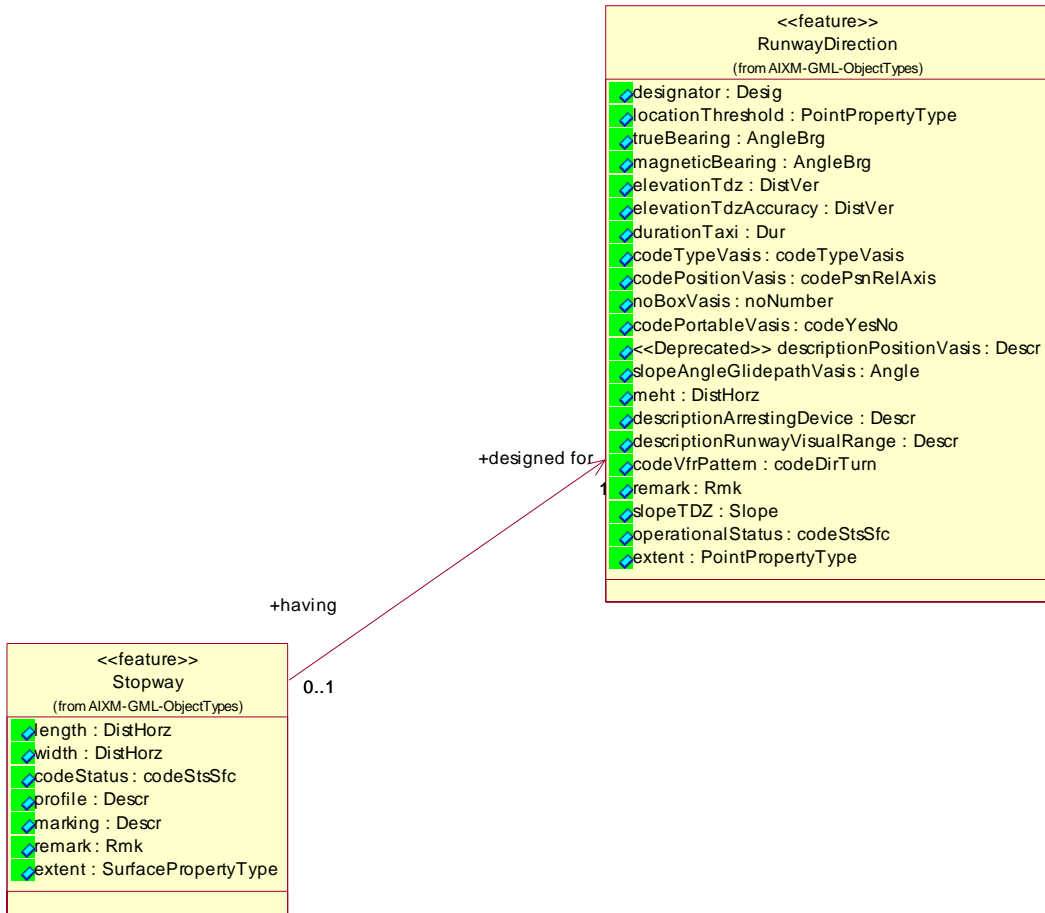


Figure 6: Modified Stopway with a geometric reference.

2.2.9 Runway Displaced Areas

AMDB	Portion of the runway that is in between the beginning of the runway and the displaced threshold. Defined using polygon geometry and is associated with both AerodromeHeliport and Threshold classes.
AIXM	No exact equivalent available.
Implementation	The newly added RunwayElement class using the “DISPLACED” value for elementType datatype used to represent this.

2.2.10 Runway Exit Lines

AMDB	Guidance line painted on the runway exit described using line geometry and associated with both AerodromeHeliport class and TaxiwayGuidanceLine
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	classes.
AIXM	No equivalent available.
Implementation	<p>Instead of adding a new class, runway exit lines are modelled by adding a new Marking class to describe markings and by adding geometric reference and directionality attributes to the Taxiway class.</p> <p>New datatype:</p> <ul style="list-style-type: none"> - styleType (SOLID, DASHED, DOTTED, OTHER) - directionType (one-way, two-way) <p>Modified class: Taxiway</p> <p>Attributes:</p> <ul style="list-style-type: none"> - directionality - extent <p>New class: Marking</p> <p>Stereotype: Object</p> <p>Attributes:</p> <ul style="list-style-type: none"> - description - color - style <p>Associations:</p> <ul style="list-style-type: none"> - beingRunwayExitLineFor/havingRunwayExitLines between Taxiway and Marking

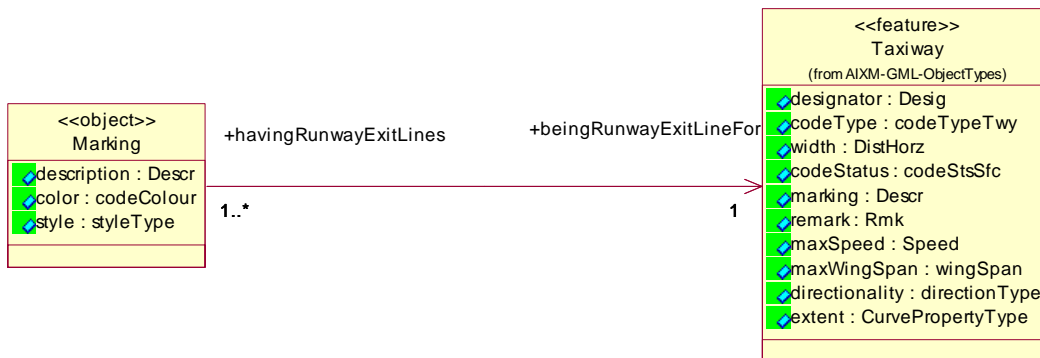


Figure 7: RunwayExitLine class with its attributes and association

2.3 Helipad Class

2.3.1 Touchdown/Lift-Off Areas (TLOFs)

AMDB	Load bearing area on which a helicopter may touchdown or lift off. Defined using polygon geometry and associated with AerodromeHeliport class.
AIXM	TouchDownLiftOff class contains all equivalent attributes except for geometry details.
Implementation	TouchDownLiftOff class is modified to include a geometric reference.

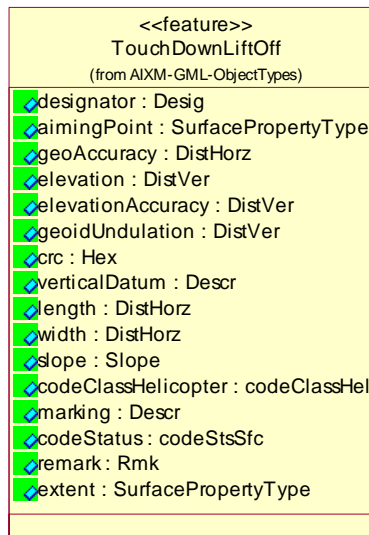


Figure 8: TouchDownLiftOff class with the newly added geometric reference.

2.4 Taxiway Class

2.4.1 Taxiway Elements

AMDB	Contains parts of Taxiway and is described with polygon geometry. Associated to AerodromeHeliport, TaxiwayGuidanceLine and Apron classes.
AIXM	No equivalent available as Taxiway class defines taxiway as a whole and not divided into smaller parts. The relationship to TaxiwayGuidanceLine in AMDB is equivalent to the one to Taxiway in AIXM.
Implementation	<p>New feature class TaxiwayElement similar to RunwayElement using elementType datatype added.</p> <p>New Class: TaxiwayElement Stereotype: Feature Attributes:</p>

	<ul style="list-style-type: none"> - type - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - isElementOf/having with Taxiway - surfaceDescribedBy/describingSurfaceOf with SurfaceCharacteristics - isSituatingOn/having between Taxiway and Apron
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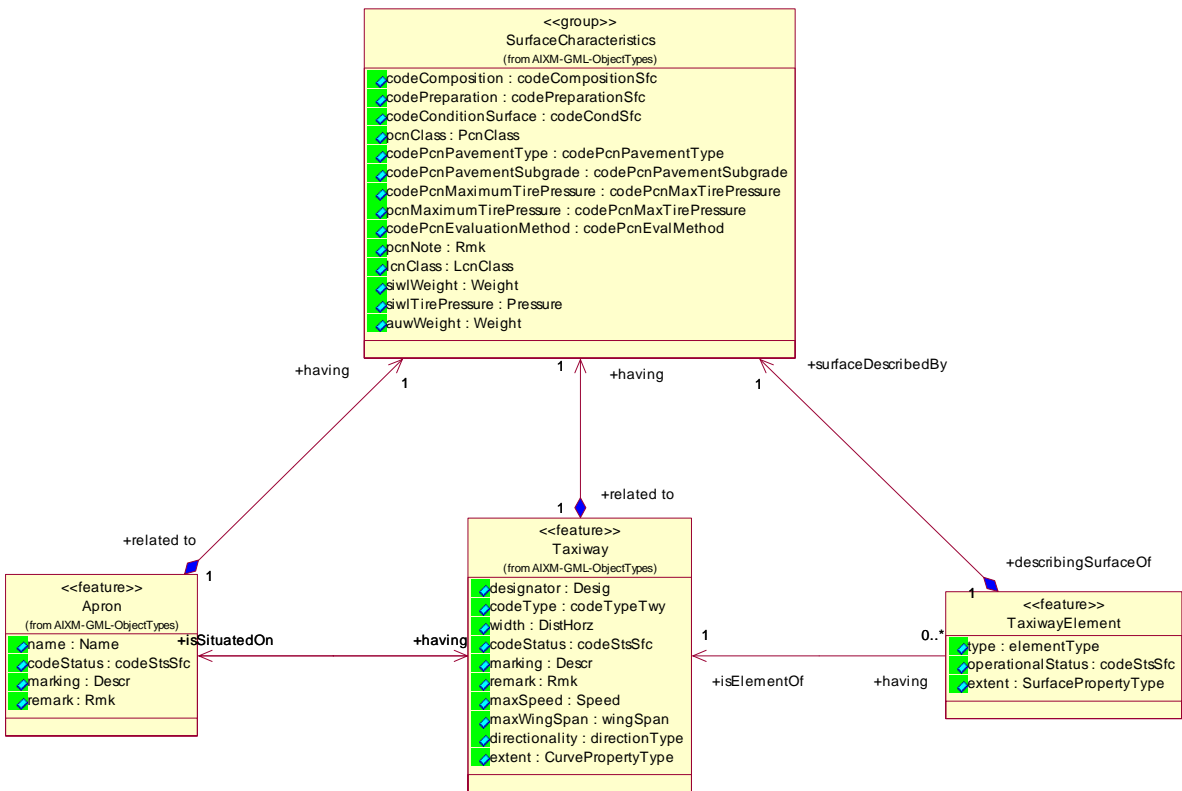


Figure 9: TaxiwayElement class with its attributes and associations

2.4.2 Taxiway Shoulders

AMDB	Area adjacent to the edge of the taxiway pavement that functions as a transition between the pavement and the adjacent surface. Defined using polygon geometry and associated with AerodromeHeliport class.
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AIXM	No equivalent available
Implementation	Modelled using the TaxiwayElement class and by using the “SHOULDER” value in the elementType datatype.

2.4.3 Taxiway Guidance Lines

AMDB	Guidance line painted on a taxiway
AIXM	No exact equivalent available. In AIXM, taxiway centreline points are used to describe a taxiway as a sequence of points, but these do not represent the precision position of the guidance line.
Implementation	<p>Instead of adding a new class to represent this, the existing Taxiway class is modified by adding attributes for speed and wingspan. The remaining attributes of color and line style is implemented by associating it with the new Marking class.</p> <p>New datatype:</p> <ul style="list-style-type: none"> - wingSpan <p>Modified class: Taxiway</p> <p>Attributes:</p> <ul style="list-style-type: none"> - maxSpeed - maxWingspan <p>Associations:</p> <ul style="list-style-type: none"> - havingGuidanceLines/beingGuidanceLineFor between Taxiway and Marking

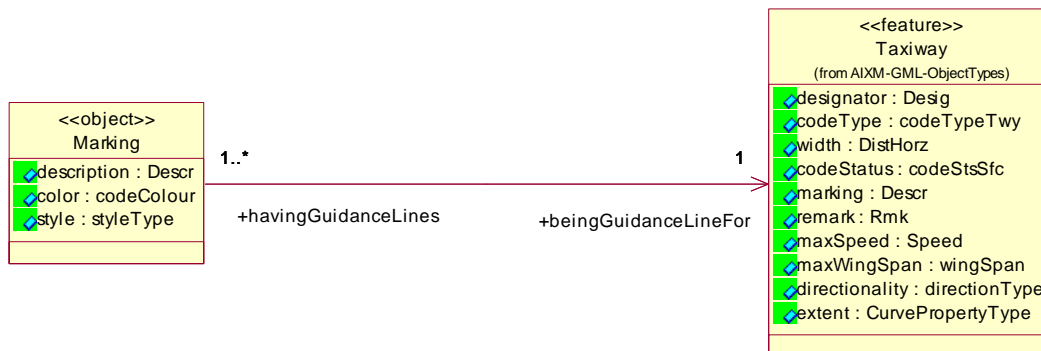


Figure 10: Taxiway class with new attributes and association with the Marking class

2.4.4 Taxiway Intersection Markings

AMDB	Taxiway intersection marking painted across a taxiway. Defined using line geometry and associated with both AerodromeHeliport and TaxiwayGuidanceLine class.
AIXM	No equivalent available. TaxiwayGuidanceLine association is represented in

	AIXM by having an association with Taxiway.
Implementation	Instead of adding a new class, the existing TaxiwayIntersection class is modified by adding a geometric reference.

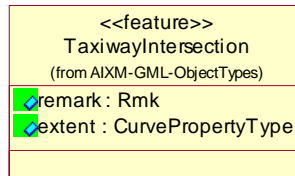


Figure 11: TaxiwayIntersection class with the newly added geometric reference

2.4.5 Taxiway Holding Positions

AMDB	Taxiway holding position painted across a taxiway. Defined using line geometry and related to Aerodrome/Heliport, TaxiwayGuidanceLine and Runway classes.
AIXM	TaxiwayHoldingPosition has some of the attributes. Association to Aerodrome/Heliport is handled by the Taxiway class.
Implementation	<p>A new attribute for describing the low visibility operation category of holding position is added using an existing datatype codeCatLdgAid. A status attribute and a geometric reference of line type are also added. Relationships are included by adding two new associations with Runway and Taxiway.</p> <p>Modify class: TaxiwayHoldingPosition</p> <p>Attributes:</p> <ul style="list-style-type: none"> - landingCategory - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - protecting/beingProtectedBy between TaxiwayHoldingPosition and Runway - protecting/beingProtectedBy between TaxiwayHoldingPosition and Taxiway.

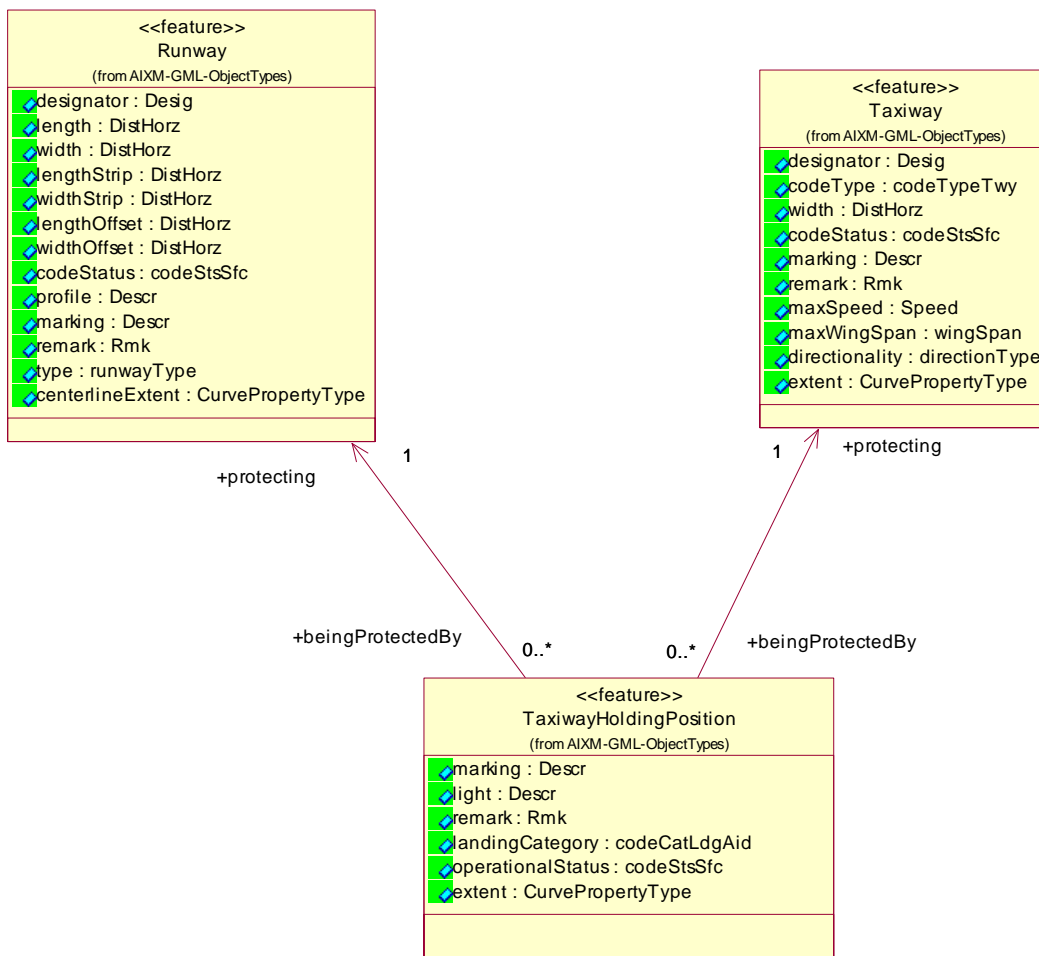


Figure 12: TaxiwayHoldingPosition class showing the newly added attributes

2.4.6 Frequency Areas

AMDB	Areas designated with specific frequency by air traffic control and ground control for surface movement. It is described using polygon geometry and is related to the Aerodrome/Heliport class.
AIXM	No equivalent available
Implementation	<p>New feature class FrequencyArea added using existing data types.</p> <p>New class: FrequencyArea Stereotype: Feature Attributes:</p> <ul style="list-style-type: none"> - frequency - station - extent <p>Associations:</p> <ul style="list-style-type: none"> - situatedAt/having with AerodromeHeliport

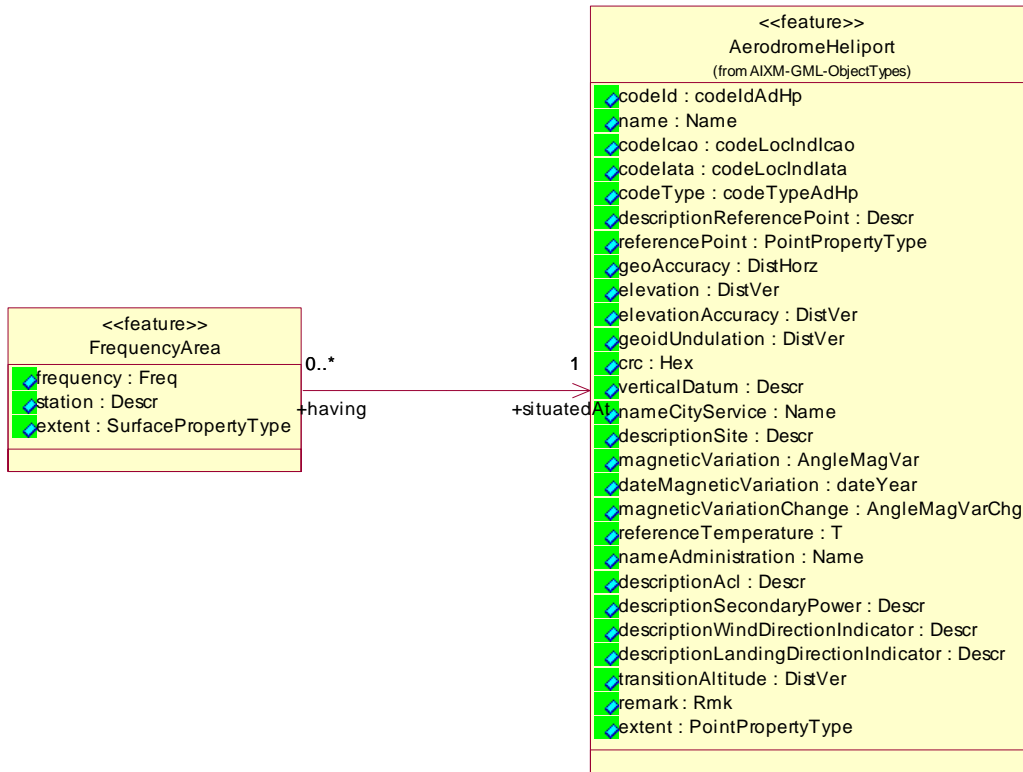


Figure 13: FrequencyArea Class

2.5 Aprons Class

2.5.1 Apron Elements

AMDB	Parts of a defined apron area that are not covered by Parking Stand Area features. Defined using polygon geometry and associated with the AerodromeHeliport class.
AIXM	No equivalent available
Implementation	<p>New feature class called ApronElement similar to RunwayElement and TaxiwayElement and using elementType datatype.</p> <p>New class: ApronElement Stereotype: Feature Attributes:</p> <ul style="list-style-type: none"> - type - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - beingElementOf/having with Apron - surfaceDescribedBy/describingSurfaceOf with SurfaceCharacteristics

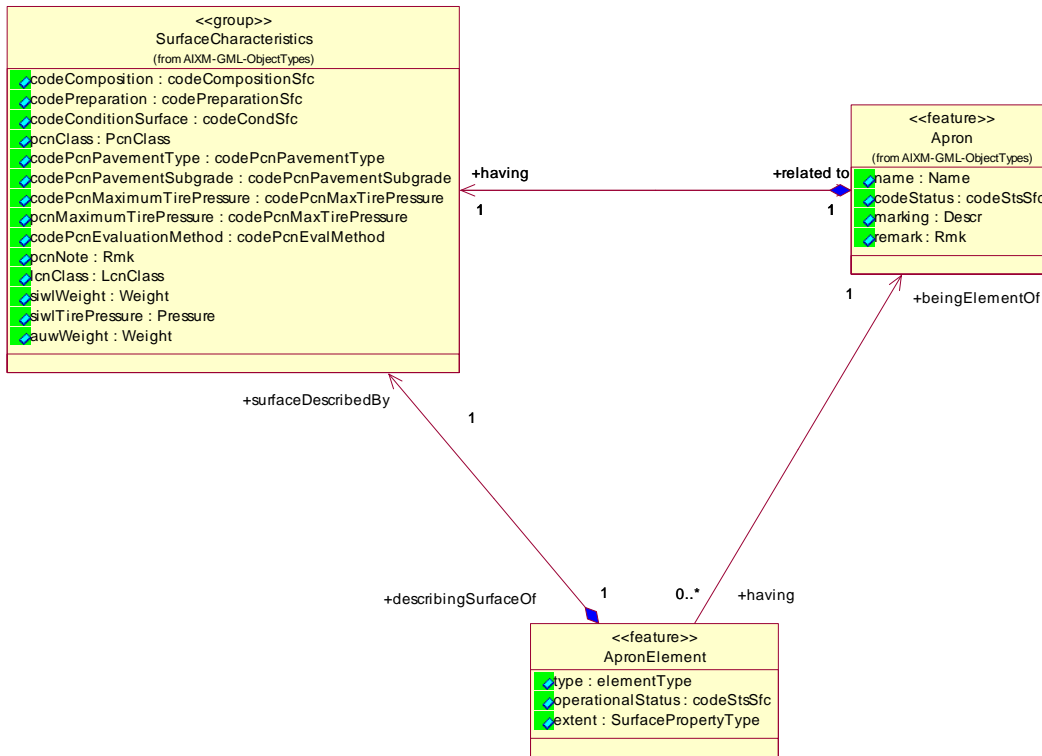


Figure 14: ApronElement class with its attributes and associations

2.5.2 Stand Guidance Lanes

AMDB	Guidance line on a designated area on an apron intended to be used for parking an aircraft. Its described using a line geometry and is related to both Aerodrome/Heliport and ParkingStand class
AIXM	Stand Guidance Lines are represented in AIXM in the Taxiway class using ‘S-TLINE’ value for the codeType attribute.
Implementation	<p>A new relationship is established between Taxiway and GateStand and also between Taxiway and Marking.</p> <p>Associations:</p> <ul style="list-style-type: none"> – having/beingGuidanceLineFor between Taxiway/GateStand – havingGuidance

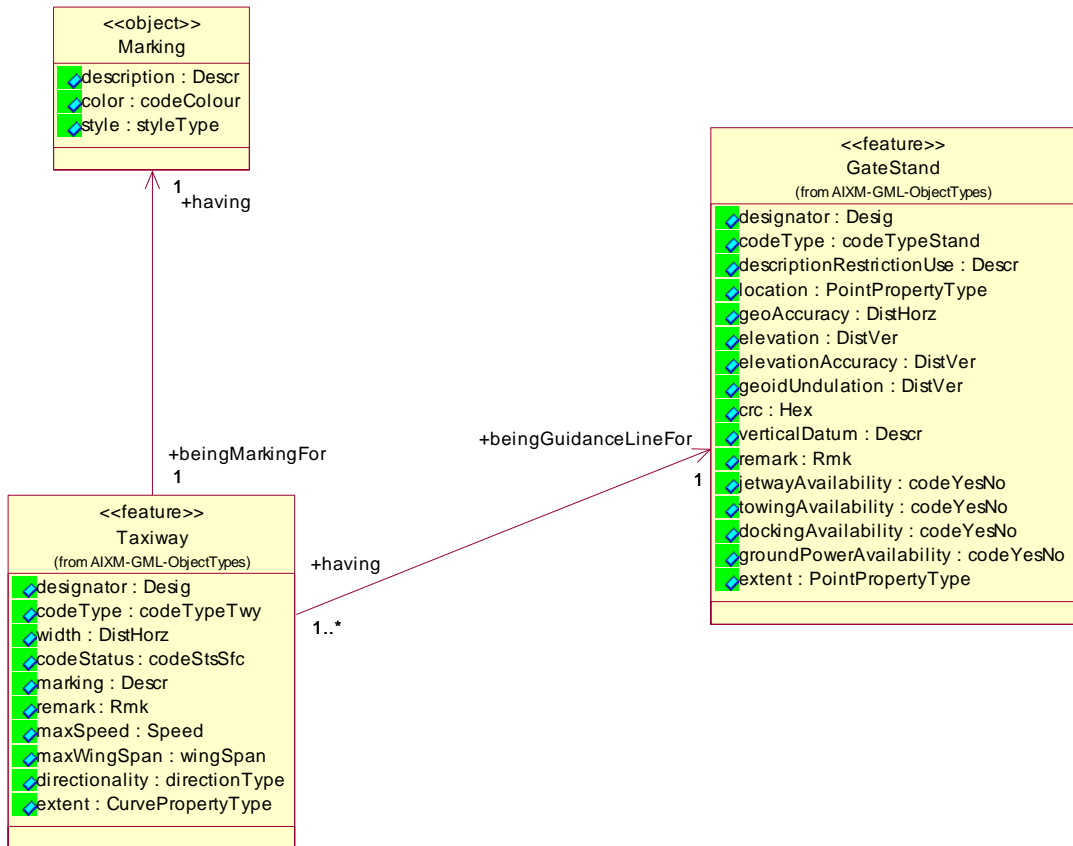


Figure 15: Classes and associations used to model Stand Guidance Lanes

2.5.3 Parking Stand Locations

AMDB	Location of an aircraft stand. Defined as a point with relationships to both Aerodrome/Heliport and ParkingStand class.
AIXM	No equivalent available. AMDB contains acn (aircraft classification number). AIXM instead uses pcn (pavement classification number) that's defined within the SurfaceCharacteristics class. ParkingStand association is equivalent to AIXM association with GateStand class.
Implementation	The existing GateStand class is modified to include a geometric reference to Point.

2.5.4 Parking Stand Areas

AMDB	A designated area on an apron intended to be used for parking an aircraft. Defined using polygon geometry. Related to Aerodrome/Heliport, ParkingStand and Apron classes.
AIXM	No exact equivalent available, but GateStand, equivalent to ParkingStand in AMDB can be extended to add the additional attributes. Also GateStand is

	associated with the Apron class, so no need to add this relationship.
Implementation	<p>GateStand is equivalent to ParkingStand in AMDB. GateStand is modified to include the additional attributes. Also GateStand has an existing relationship with the Apron class.</p> <p>Modify class: GateStand</p> <p>Attributes:</p> <ul style="list-style-type: none">- jetwayAvailability- towingAvailability- dockingAvailability- groundPowerAvailability <p>Associations:</p> <ul style="list-style-type: none">- surfaceDescribedBy/describingSurfaceOf with SurfaceCharacteristics- association with fuel class

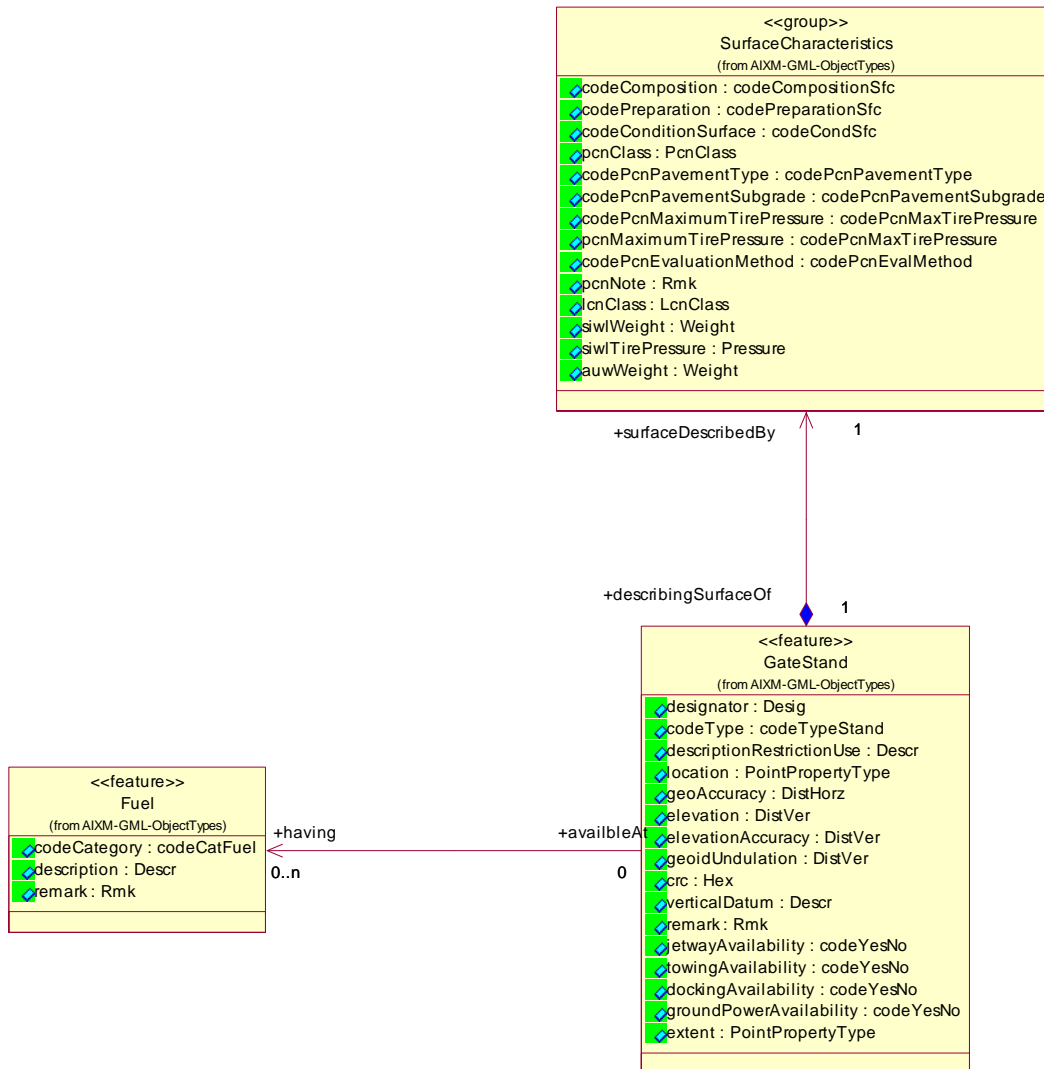


Figure 16: GateStand class with its new attributes and associations

2.5.5 Deicing Areas

AMDB	An area comprising an inner area for the parking of an airplane to receive de-icing treatment and outer area for the maneuvering of two or more mobile de-icing equipments. Defined using polygon geometry and associated with both AerodromeHeliport and TaxiwayElement or ParkingStandArea or ApronElement classes.
AIXM	No equivalent available
Implementation	<p>New feature class DeicingArea added to describe this feature.</p> <p>New class: DeicingArea</p> <p>Stereotype: Feature</p> <p>Attributes:</p>

	<ul style="list-style-type: none"> - name - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - surfaceDescribedBy/describingSurfaceOf with SurfaceCharacteristics - situatedAt/having with Aerodrome/Heliport - isSituatingOn/having with GateStand
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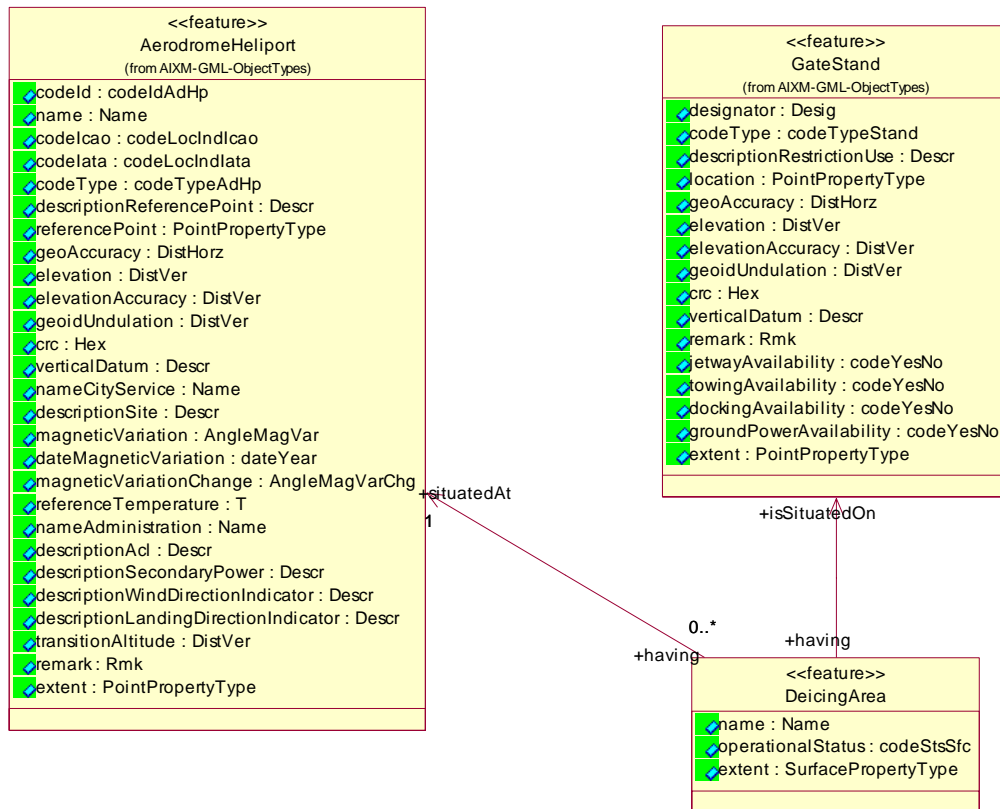


Figure 17: DeicingArea class with its attributes and its associations.

2.5.6 Service Roads

AMDB	Part of aerodrome surfaces used by service vehicles. Defined using polygon geometry and associated with both AerodromeHeliport and TaxiwayElement or ParkingStandArea or ApronElement classes.
AIXM	No equivalent available
Implementation	New feature class ServiceRoad added to describe this feature.

	<p>New class: ServiceRoad</p> <p>Stereotype: Feature</p> <p>Attributes:</p> <ul style="list-style-type: none"> - name - operationalStatus - extent <p>Associations:</p> <ul style="list-style-type: none"> - situatedAt/having with AerodromeHeliport - situatedOn/having with GateStand
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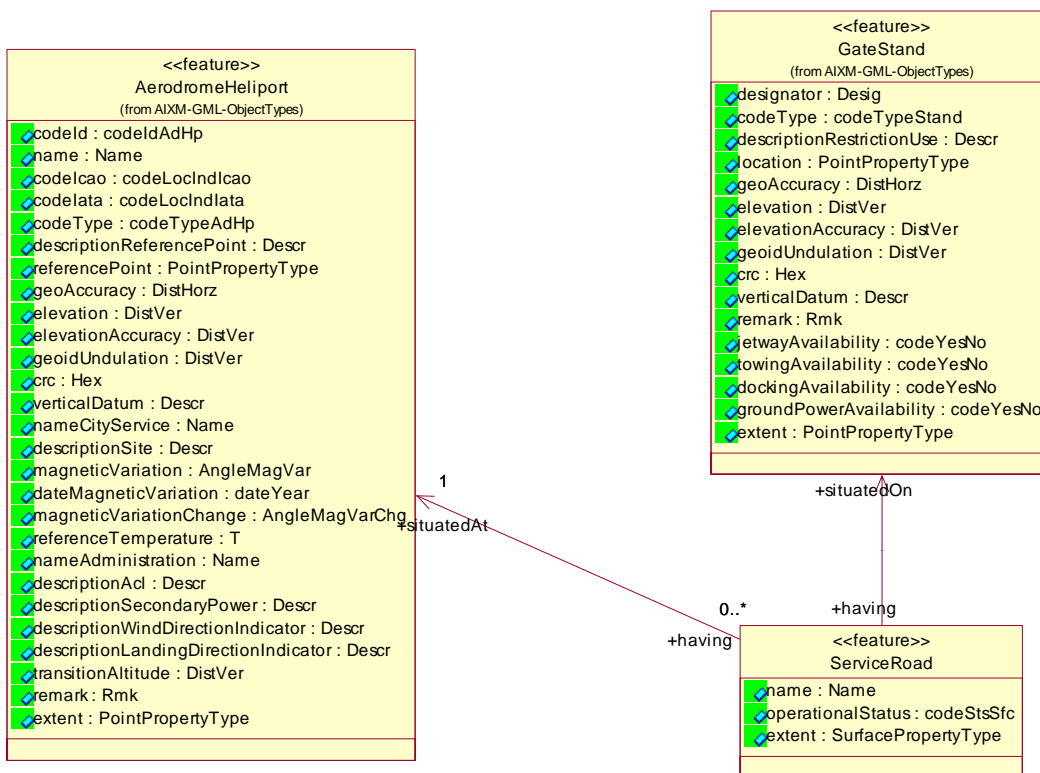


Figure 18: ServiceRoad class with its attributes and associations.

2.5.7 Aerodrome Reference Point

AMDB	The designated geographical location of an aerodrome. Defined as a point.
AIXM	Aerodrome reference point is included in the AerodromeHeliport class.
Implementation	Modified AerodromeHeliport class to include a point geometry reference.

2.5.8 Construction Area

AMDB	Part of a movement area under construction. Defined using polygon geometry and related to AerodromeHeliport class.
AIXM	No equivalent available
Implementation	<p>New feature class ConstructionArea added to handle this feature. Since the temporality model would add many of the proposed attributes, only the plannedOperationalDate attribute is added in addition to the geometric reference using a polygon type.</p> <p>New class: ConstructionArea Stereotype: Feature Attributes:</p> <ul style="list-style-type: none">– description– plannedOperationalDate– extent <p>Associations:</p> <ul style="list-style-type: none">– situatedAt/having with AerodromHeliport–

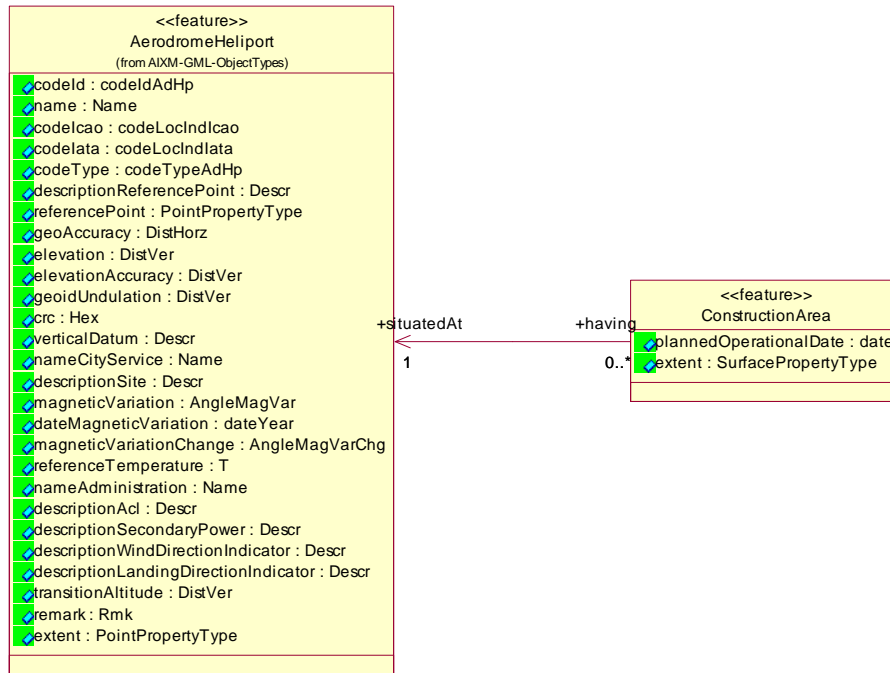


Figure 19: ConstructionArea class with its attributes and associations.

2.6 Quality Data Class

2.6.1 Survey Control Points

AMDB	Survey control point defined using point geometry and associated with the AerodromeHeliport class.
AIXM	No equivalent available
Implementation	<p>New feature class SurveyControlPoint added to handle this feature. The proposed attributes of vdatum, project, spheroid, hdatum are not added as these will be handled by the geometric reference.</p> <p>New class: SurveyControlPoint</p> <p>Stereotype: Feature</p> <p>Attributes:</p> <ul style="list-style-type: none"> - description - extent <p>Associations:</p> <ul style="list-style-type: none"> - situatedAt/having with AerodromHeliport

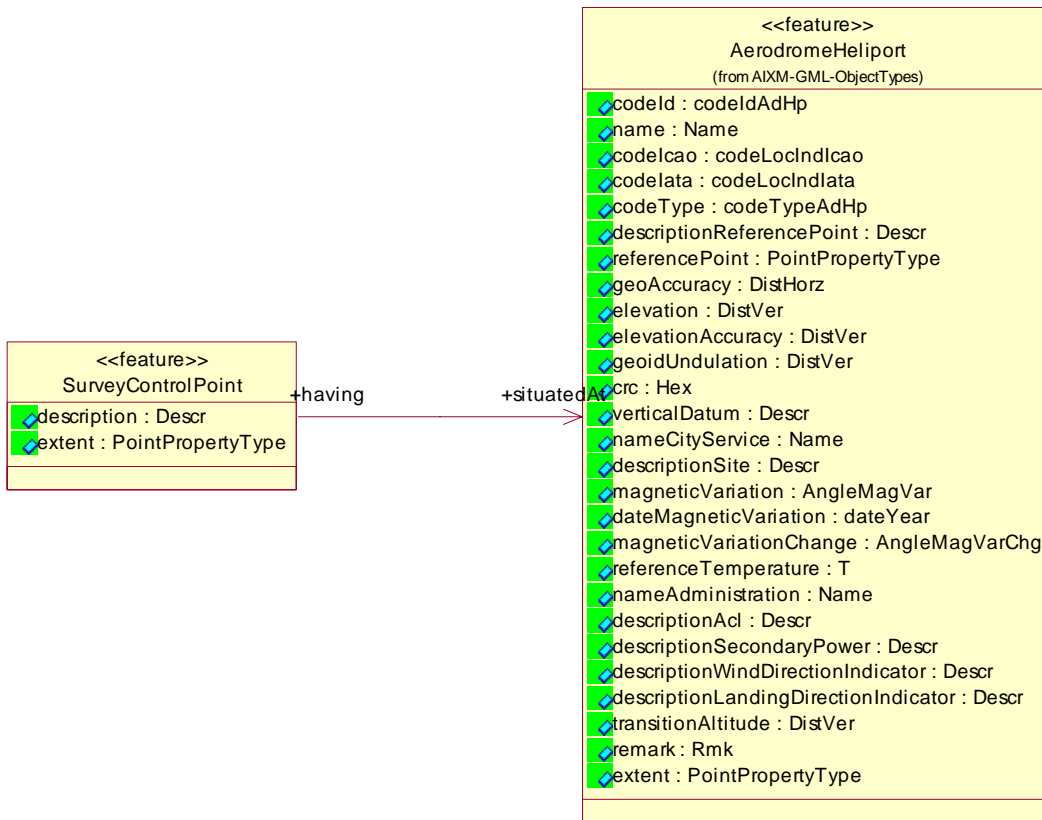


Figure 20: SurveyControlPoint class with its attributes and associations.

2.7 Final Approach and Take Off

This recommendation was not part of the gap analyses, but came out during the review of the gap analyses. It was recommended to remove the FinalApproachTakeOff class from the model and replace it with a type attribute in the Runway class. This is because Runway class essentially has all information provided through the FinalApproachTakeOff class. The changes made to the model are listed below.

Implementation	<ul style="list-style-type: none"> – New data type called runwayType with values RWY and FATO to represent runway for airplanes and final approach and take off area for helicopters respectively. – Modified Runway class to include a new attribute called type using runwayType data type. – Modified codeTypeAlsRwy to include new value “H” for perimeter approach lights. – Modified codeTypeDeclDistRwy to include “TODAH” (Take-Off Distance Available), “RTODAH” (Rejected TODA for helicopters), and
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“LDAH” (LDA for helicopters).

- Replaced the relationship between TouchDownLiftOff with FinalApproachTakeOff with a relationship between TouchDownLiftOff and Runway.

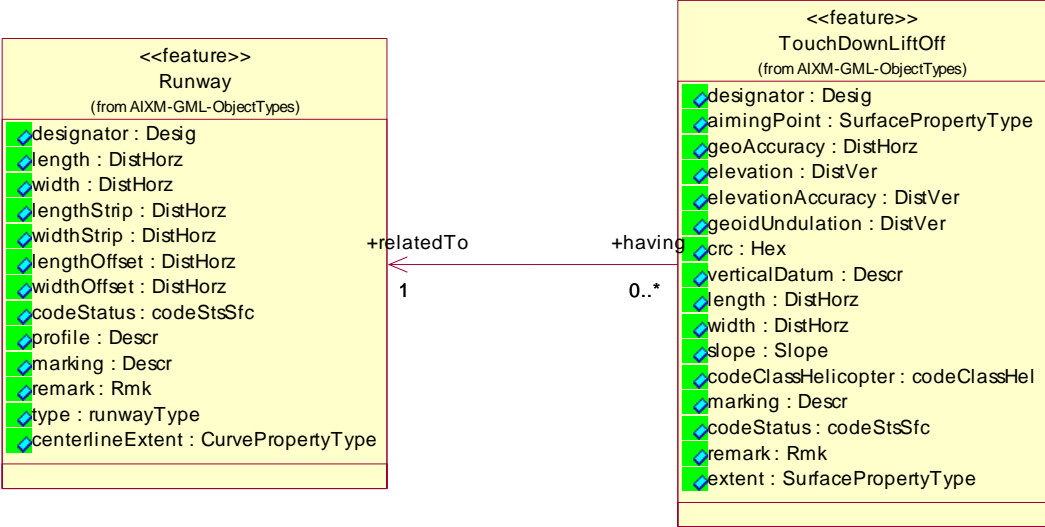


Figure 21: Runway class with new attribute and association with the TouchDownLiftOff