

**OGC® DOCUMENT: 18-067R4**

External identifier of this OGC® document: <http://www.opengis.net/doc/IS/symbology-1/2.0>



Open  
Geospatial  
Consortium

# OGC STYLES AND SYMBOLLOGY MODEL AND ENCODINGS - PART 1: CORE

---

**STANDARD**  
Implementation

**CANDIDATE SWG DRAFT**

**Version:** 2.0

**Submission Date:** 2029-01-01

**Approval Date:** 2029-01-01

**Publication Date:** 2029-01-01

**Editor:** Erwan Bocher, Olivier Ertz, Jerome Jacovella-St-Louis, Maxime Collombin

**Notice for Drafts:** This document is not an OGC Standard. This document is distributed for review and comment. This document is subject to change without notice and may not be referred to as an OGC Standard.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

### License Agreement

Use of this document is subject to the license agreement at <https://www.ogc.org/license>

Suggested additions, changes and comments on this document are welcome and encouraged. Such suggestions may be submitted using the online change request form on OGC web site: <http://ogc.standardstracker.org/>

### Copyright notice

Copyright © 2023 Open Geospatial Consortium

To obtain additional rights of use, visit <https://www.ogc.org/legal>

### Note

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

# CONTENTS

---

|      |   |     |
|------|---|-----|
| I.   | ABSTRACT .....  | xi  |
| II.  | KEYWORDS .....  | xi  |
| III. | PREFACE .....   | xii |
| IV.  | SECURITY CONSIDERATIONS .....                                     | xiv |
| V.   | SUBMITTING ORGANIZATIONS .....                                    | xv  |
| VI.  | SUBMITTERS .....  | xv  |
| 1.   | SCOPE .....   | 2   |
| 2.   | CONFORMANCE .....   | 4   |
| 2.1. | Requirements classes for basic portrayal .....                    | 4   |
| 2.2. | Requirements classes for common portrayal capabilities .....      | 5   |
| 2.3. | Requirements classes for additional expression capabilities ..... | 6   |
| 2.4. | Requirements classes for advanced stroke and fills .....          | 7   |
| 2.5. | Requirements classes for additional portrayal capabilities .....  | 8   |
| 2.6. | Requirements classes defining encodings .....                     | 8   |
| 2.7. | Declaration of conformance .....                                  | 9   |
| 3.   | NORMATIVE REFERENCES .....  | 13  |
| 4.   | TERMS AND DEFINITIONS .....                                       | 15  |
| 5.   | CONVENTIONS .....   | 18  |
| 5.1. | Abbreviated terms .....   | 18  |
| 6.   | OVERVIEW .....  | 20  |
| 7.   | REQUIREMENTS CLASS “CORE” .....                                   | 23  |
| 7.1. | Overview .....  | 23  |
| 7.2. | Requirements .....  | 33  |
| 8.   | REQUIREMENTS CLASS “BASIC VECTOR FEATURES STYLING” .....          | 41  |
| 8.1. | Overview .....  | 41  |
| 8.2. | Requirements .....  | 52  |
| 9.   | REQUIREMENTS CLASSES FOR COVERAGE STYLING .....                   | 57  |

|  |            |
|--|------------|
| 9.1. Requirements Class “Basic Coverage Styling” .....                       | 57         |
| 9.2. Requirements Class “Hill Shading” .....                                 | 62         |
| <b>10. REQUIREMENTS CLASSES FOR LABELING .....</b>                           | <b>67</b>  |
| 10.1. Requirements Class “Basic Labeling” .....                              | 67         |
| 10.2. Requirements Class “Font Outlines” .....                               | 68         |
| <b>11. REQUIREMENTS CLASSES FOR SHAPES .....</b>                             | <b>71</b>  |
| 11.1. Requirements Class “Shape Graphics” .....                              | 71         |
| 11.2. Requirements Class “Shapes Outlines” .....                             | 76         |
| <b>12. REQUIREMENTS CLASS “MULTI GRAPHICS AND TRANSFORMS” .....</b>          | <b>78</b>  |
| 12.1. Overview .....   | 78         |
| 12.2. Requirements .....   | 79         |
| <b>13. REQUIREMENTS CLASSES FOR ADVANCED STROKES .....</b>                   | <b>81</b>  |
| 13.1. Requirements Class “Joins and Caps” .....                              | 81         |
| 13.2. Requirements Class “Dashes” .....                                      | 82         |
| 13.3. Requirements Class “Casing and Centerline” .....                       | 83         |
| 13.4. Requirements Class “Pattern Strokes” .....                             | 84         |
| <b>14. REQUIREMENTS CLASSES FOR ADVANCED FILLS .....</b>                     | <b>86</b>  |
| 14.1. Requirements Class “Pattern Fills” .....                               | 86         |
| 14.2. Requirements Class “Hatches and Gradients, Stipples” .....             | 87         |
| <b>15. REQUIREMENTS CLASS “SYMBOLIZER PARAMETER VALUE EXPRESSIONS” .....</b> | <b>91</b>  |
| 15.1. Overview .....   | 91         |
| 15.2. Requirements .....   | 91         |
| <b>16. REQUIREMENTS CLASSES FOR ADDITIONAL EXPRESSIONS .....</b>             | <b>93</b>  |
| 16.1. Requirements Class “Any right-hand operands” .....                     | 93         |
| 16.2. Requirements Class “Conditional Expressions” .....                     | 93         |
| 16.3. Requirements Class “Variables” .....                                   | 94         |
| <b>17. REQUIREMENTS CLASSES FOR ADDITIONAL OPERATORS .....</b>               | <b>97</b>  |
| 17.1. Requirements Class “Arithmetic Operators” .....                        | 97         |
| 17.2. Requirements Class “Bitwise Operators” .....                           | 98         |
| 17.3. Requirements Class “Text Relation Operators” .....                     | 99         |
| <b>18. REQUIREMENTS CLASSES FOR FUNCTIONS .....</b>                          | <b>102</b> |
| 18.1. Requirements Class “Function Expressions” .....                        | 102        |
| 18.2. Requirements Class “Spatial Relation Functions” .....                  | 104        |
| 18.3. Requirements Class “Temporal Relation Functions” .....                 | 111        |
| 18.4. Requirements Class “Array Relation Functions” .....                    | 113        |
| 18.5. Requirements Class “Text Manipulation Functions” .....                 | 114        |
| 18.6. Requirements Class “Geometry Manipulation Functions” .....             | 116        |

|  |            |
|--|------------|
| 19. REQUIREMENTS CLASS “3D MODELS AND TRANSFORMS” .....  | 119        |
| 19.1. Overview .....   | 119        |
| 19.2. Requirements .....   | 121        |
| 20. REQUIREMENTS CLASS “JSON STYLES AND SYMBOLOGY” .....   | 123        |
| 20.1. Overview .....   | 123        |
| 20.2. Requirements .....   | 123        |
| 21. REQUIREMENTS CLASS “CASCADING CARTOGRAPHIC SYMBOLOGY STYLE SHEETS” .....                               | 125        |
| 21.1. Overview .....   | 125        |
| 21.2. Requirements .....   | 130        |
| <b>ANNEX A (NORMATIVE) ABSTRACT TEST SUITE .....</b>   | <b>132</b> |
| A.1. Conformance Class “Core” .....  | 132        |
| A.2. Conformance Class “Basic Vector Features Styling” .....   | 133        |
| A.3. Conformance Class “Basic Coverage Styling” .....  | 133        |
| <b>ANNEX B (INFORMATIVE) MAPPING OF SLD/SE AND NOTABLE VENDOR EXTENSIONS TO THE CONCEPTUAL MODEL .....</b> | <b>136</b> |
| <b>ANNEX C (INFORMATIVE) PORTRAYAL USE CASES GALLERY .....</b>   | <b>138</b> |
| <b>ANNEX D (INFORMATIVE) REVISION HISTORY .....</b>  | <b>140</b> |
| <b>BIBLIOGRAPHY .....</b>  | <b>142</b> |

## LIST OF TABLES

---

|  |       |
|--|-------|
| Table .....                                      | ..... |
| Table 1 – Conformance class URLs .....           | 9     |
| Table 2 – Style class .....                      | 24    |
| Table 3 – StylingRule .....                      | 24    |
| Table 4 – Symbolizer class .....                 | 24    |
| Table 5 – Visualization System Identifiers ..... | 28    |
| Table 6 – Layer System Identifiers .....         | 28    |
| Table 7 – Month enumeration .....                | 28    |
| Table 8 – Date class .....                       | 29    |
| Table 9 – TimeOfDay class .....                  | 29    |
| Table 10 – Class TimelInstant .....              | 29    |
| Table 11 – OperationExpression class .....       | 31    |
| Table 12 – Logical Operators .....               | 31    |

|   |    |
|---|----|
| Table 13 – Relational Operators .....                         | 32 |
| Table 14 – Symbolizer class (vector features extension) ..... | 41 |
| Table 15 – System identifiers for vector features .....       | 42 |
| Table 16 – Color class .....                                  | 43 |
| Table 17 – Fill class .....                                   | 44 |
| Table 18 – StrokeStyling class .....                          | 45 |
| Table 19 – MultiGraphic class .....                           | 47 |
| Table 20 – Graphic class .....                                | 47 |
| Table 21 – FloatPoint class .....                             | 48 |
| Table 22 – Shape .....  | 48 |
| Table 23 – Image .....  | 49 |
| Table 24 – Resource class .....                               | 50 |
| Table 25 – Text .....   | 51 |
| Table 26 – TextAlignement .....                               | 51 |
| Table 27 – HAlignment enumeration .....                       | 51 |
| Table 28 – VAlignment enumeration .....                       | 51 |
| Table 29 – Font class .....                                   | 52 |
| Table 30 – Extended Symbolizer properties .....               | 58 |
| Table 31 – ValueColor properties .....                        | 58 |
| Table 32 – ValueOpacity properties .....                      | 59 |
| Table 33 – Color .....  | 59 |
| Table 34 – Extended Symbolizer properties .....               | 63 |
| Table 35 – HillShading properties .....                       | 63 |
| Table 36 – AzimuthElevation properties .....                  | 63 |
| Table 37 – Extended Symbolizer Class .....                    | 67 |
| Table 38 – Extended Text Class .....                          | 68 |
| Table 39 – FontOutline class .....                            | 69 |
| Table 40 – Class ClosedShape .....                            | 72 |
| Table 41 – Rectangle .....                                    | 72 |
| Table 42 – Class RoundRectangle .....                         | 72 |
| Table 43 – Class Circle .....                                 | 72 |
| Table 44 – Class Ellipse .....                                | 73 |
| Table 45 – Arc class .....                                    | 73 |
| Table 46 – SectorArc class .....                              | 74 |
| Table 47 – ChordArc class .....                               | 74 |
| Table 48 – Path class .....                                   | 75 |
| Table 49 – ClosedPath class .....                             | 76 |
| Table 50 – ShapeOutline class .....                           | 76 |
| Table 51 – Extended Shape class .....                         | 76 |
| Table 52 – Extended Graphic class .....                       | 79 |
| Table 53 – Transform2D class .....                            | 79 |

|   |     |
|---|-----|
| Table 54 – GraphicInstance class .....                                | 79  |
| Table 55 – Extended Stroke class .....                                | 81  |
| Table 56 – StrokeJoin enumeration .....                               | 82  |
| Table 57 – StrokeCap enumeration .....                                | 82  |
| Table 58 – Extended Stroke class .....                                | 83  |
| Table 59 – Extended Stroke class .....                                | 83  |
| Table 60 – Extended Stroke class .....                                | 84  |
| Table 61 – Extended Fill class .....                                  | 86  |
| Table 62 – Extended Fill class .....                                  | 87  |
| Table 63 – ColorKey class .....                                       | 88  |
| Table 64 – StippleStyle class .....                                   | 88  |
| Table 65 – HatchStyle class .....                                     | 88  |
| Table 66 – ConditionalExpression class .....                          | 94  |
| Table 67 – VariableExpression class .....                             | 94  |
| Table 68 – arithmetic .....   | 97  |
| Table 69 – bitwise .....  | 98  |
| Table 70 – comparison .....   | 100 |
| Table 71 – FunctionCallExpression class .....                         | 102 |
| Table 72 – Function class .....                                       | 103 |
| Table 73 – Standard functions URI mapping .....                       | 103 |
| Table 74 – Spatial relation functions .....                           | 104 |
| Table 75 – BoundingBox class .....                                    | 106 |
| Table 76 – Point class .....  | 107 |
| Table 77 – MultiPoint class .....                                     | 107 |
| Table 78 – LineString class .....                                     | 107 |
| Table 79 – MultiLineString class .....                                | 107 |
| Table 80 – Polygon class .....  | 108 |
| Table 81 – MultiPolygon class .....                                   | 109 |
| Table 82 – GeometryCollection class .....                             | 110 |
| Table 83 – TimeInterval class .....                                   | 112 |
| Table 84 – Temporal relation functions acting on time instants .....  | 112 |
| Table 85 – Temporal relation functions acting on time intervals ..... | 112 |
| Table 86 – Array relation functions .....                             | 114 |
| Table 87 – Text manipulation functions .....                          | 115 |
| Table 88 – Geometry manipulation functions .....                      | 116 |
| Table 89 – Extended Graphic class .....                               | 120 |
| Table 90 – Model class .....  | 120 |
| Table 91 – Transform3D class .....                                    | 120 |
| Table 92 – Vector3D class .....                                       | 120 |
| Table 93 – FloatVector3D class .....                                  | 120 |
| Table 94 – Quaternion class .....                                     | 121 |

## LIST OF FIGURES

---

|  |     |
|--|-----|
| Figure 1 – Symbology Core Classes UML Diagram .....                          | 23  |
| Figure 2 – Expression Classes UML Diagram .....                              | 25  |
| Figure 3 – System Identifiers UML Diagram .....                              | 27  |
| Figure 4 – Literal Classes UML Diagram .....                                 | 30  |
| Figure 5 – Core Logic and Relational Operators UML Diagram .....             | 31  |
| Figure 6 – Basic Vector Features Extended Symbolizer Class UML Diagram ..... | 41  |
| Figure 7 – Vector Features System Identifiers UML Class Diagram .....        | 42  |
| Figure 8 – Color class UML Diagram .....                                     | 43  |
| Figure 9 – UML Class Diagram of the Symbology Fill .....                     | 44  |
| Figure 10 – Stroke Class UML Diagram .....                                   | 45  |
| Figure 11 – Graphical Units Enumeration UML Diagram .....                    | 46  |
| Figure 12 – Marker Class UML Diagram .....                                   | 47  |
| Figure 13 – Dot Class UML Diagram .....                                      | 48  |
| Figure 14 – Image Class UML Diagram .....                                    | 49  |
| Figure 15 – Text Class UML Diagram .....                                     | 50  |
| Figure 16 – Extended Symbolizer Class UML Diagram .....                      | 57  |
| Figure 17 – Extended Symbolizer Class UML Diagram .....                      | 62  |
| Figure 18 – Label Class UML Diagram .....                                    | 67  |
| Figure 19 – Font outlines UML Diagram .....                                  | 68  |
| Figure 20 – Rectangles, Circles and Ellipses Classes UML Diagram .....       | 71  |
| Figure 21 – Arc Classes UML Diagram .....                                    | 73  |
| Figure 22 – Path Classe UML Diagram .....                                    | 75  |
| Figure 23 – MultiGraphic and Transforms UML Diagram .....                    | 78  |
| Figure 24 – Joins and Caps classes UML diagram .....                         | 81  |
| Figure 25 – Dashed strokes class UML diagram .....                           | 82  |
| Figure 26 – Casing and centerline strokes class UML diagram .....            | 83  |
| Figure 27 – Pattern strokes class UML Diagram .....                          | 84  |
| Figure 28 – Pattern Fill UML Diagram .....                                   | 86  |
| Figure 29 – Hatches, Gradients and Stipple Fills UML Diagram .....           | 87  |
| Figure 30 – Conditional Expressions UML Class Diagram .....                  | 93  |
| Figure 31 – Variable Expressions UML Class Diagram .....                     | 94  |
| Figure 32 – Arithmetic Operators UML Diagram .....                           | 97  |
| Figure 33 – Bitwise Operators UML Diagram .....                              | 98  |
| Figure 34 – Bitwise Operators UML Diagram .....                              | 99  |
| Figure 35 – Functions UML Class Diagram .....                                | 102 |

|   |     |
|---|-----|
| Figure 36 – Spatial Relation Functions UML Diagram .....        | 104 |
| Figure 37 – Geometry System Identifiers UML Class Diagram ..... | 105 |
| Figure 38 – Geometry Classes UML Diagram .....                  | 106 |
| Figure 39 .....   | 108 |
| Figure 40 .....   | 108 |
| Figure 41 .....   | 109 |
| Figure 42 .....   | 109 |
| Figure 43 .....   | 109 |
| Figure 44 – Temporal Relation Functions UML Diagram .....       | 111 |
| Figure 45 – Array Relation Functions UML Diagram .....          | 113 |
| Figure 46 – Text Manipulation Functions UML Diagram .....       | 114 |
| Figure 47 – Geometry Manipulation Functions UML Diagram .....   | 116 |
| Figure 48 .....   | 119 |

## LIST OF RECOMMENDATIONS

---

|   |    |
|---|----|
| REQUIREMENTS CLASS 1: CORE .....                          | 33 |
| REQUIREMENTS CLASS 2: BASIC VECTOR FEATURES STYLING ..... | 52 |
| REQUIREMENTS CLASS 3: BASIC COVERAGE STYLING .....        | 59 |
| REQUIREMENTS CLASS 4: HILL SHADING .....                  | 63 |
| REQUIREMENT 1 .....                                       | 33 |
| REQUIREMENT 2 .....                                       | 34 |
| REQUIREMENT 3 .....                                       | 34 |
| REQUIREMENT 4 .....                                       | 34 |
| REQUIREMENT 5 .....                                       | 35 |
| REQUIREMENT 6 .....                                       | 35 |
| REQUIREMENT 7 .....                                       | 35 |
| REQUIREMENT 8 .....                                       | 35 |
| REQUIREMENT 9 .....                                       | 36 |
| REQUIREMENT 10 .....                                      | 36 |
| REQUIREMENT 11 .....                                      | 36 |
| REQUIREMENT 12 .....                                      | 37 |
| REQUIREMENT 13 .....                                      | 37 |
| REQUIREMENT 14 .....                                      | 37 |
| REQUIREMENT 15 .....                                      | 38 |

|                             |     |
|-----------------------------|-----|
| REQUIREMENT 16 .....        | 38  |
| REQUIREMENT 17 .....        | 38  |
| REQUIREMENT 18 .....        | 38  |
| REQUIREMENT 19 .....        | 39  |
| REQUIREMENT 20 .....        | 52  |
| REQUIREMENT 21 .....        | 53  |
| REQUIREMENT 22 .....        | 53  |
| REQUIREMENT 23 .....        | 53  |
| REQUIREMENT 24 .....        | 54  |
| REQUIREMENT 25 .....        | 54  |
| REQUIREMENT 26 .....        | 54  |
| REQUIREMENT 27 .....        | 55  |
| REQUIREMENT 28 .....        | 55  |
| REQUIREMENT 29 .....        | 60  |
| REQUIREMENT 30 .....        | 60  |
| REQUIREMENT 31 .....        | 60  |
| REQUIREMENT 32 .....        | 61  |
| REQUIREMENT 33 .....        | 61  |
| REQUIREMENT 34 .....        | 64  |
| REQUIREMENT 35 .....        | 64  |
| REQUIREMENT 36 .....        | 64  |
| REQUIREMENT 37 .....        | 65  |
| REQUIREMENT 38 .....        | 65  |
| CONFORMANCE CLASS A.1 ..... | 132 |
| CONFORMANCE CLASS A.2 ..... | 133 |
| CONFORMANCE CLASS A.3 ..... | 133 |

# ABSTRACT

---

This OGC *Styles and Symbology* Standard defines a Conceptual Model, a Logical Model and Encodings for describing symbology rules for the portrayal of geographical data. The targets of this Standard are symbology encodings and cartographic rendering engines.

The Standard is modularized into multiple requirements classes, with a minimal core describing an extensible framework, with clear extension points, for defining styles consisting of styling rules selected through expressions and applying symbolizers configured using properties.

The Standard defines a number of additional conformance classes covering a large number of essential portrayal use cases for symbolizing both vector data and coverage data.

Finally, the Standard defines two encodings for the logical model: one based on JSON which can be readily parsed by JSON parsers, as well as a more expressive encoding better suited for hand-editing inspired from Web Cartographic Styled Sheets (CSS) and related cartographic symbology encodings.

Additional encodings can be defined that can conform to the logical model, and existing encodings can be mapped fully or partially to the conceptual model defined in this Standard.

The granularity of the requirements classes facilitates conformance for encodings and rendering engines based on their supported capabilities.

Future parts may extend this Standard by defining additional symbolizer properties, system identifiers, or new types of expressions.

# KEYWORDS

---

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, style, symbology, conceptual, core, modular, neutral, portrayal

**Preface:** This Standard is intended as a successor to the Symbology Encoding standard (SE 1.1) and the OGC Symbology Core Conceptual Model ("SymCore" 1.0). This Standard focuses primarily on describing symbology rules to be applied by a rendering engine to symbolize geospatial data. It also features a rich and extensible selector expression system which determines whether a particular symbology rule is to be applied or not by the rendering engine. In particular, it introduces a "system identifier" which can be mapped to concepts such as a particular layer, feature type or collection. Such concepts are used in OGC Web Services (including the Web Mapping Service (WMS) Style Layer Descriptor profile (SLD)), Web API Standards such as OGC API – Maps to render the data, and OGC API – Styles to provide styles, as well as data stores such as OGC GeoPackage (in which styles could also be stored using a portrayal extension). This Standard therefore follows the same motivation that split up SLD 1.0 (SLD 1.1 and SE 1.1) and defines requirements are not specific to any service (e.g., Web Map Service), are independent, and allow the concepts to be reused by other Standards willing to address aspects related to cartography. A general and portable symbology model is defined for use across the broad OGC Standards baseline, to be applied to geospatial datasets as well as online geospatial data and mapping services.

An important goal of this Standard is to enable richer symbology capabilities. This can be achieved through modularity which comes with extensibility. SE 1.1 is not modular per se, while this Standard is designed to be so by defining multiple requirements classes and the ability to conform with them at either the conceptual level or at the logical model. It also defines requirements classes for two encodings conforming to both the logical model and the conceptual model. The core conformance class covers the basic mechanics of defining a Style with StylingRules applying a Symbolizer, as well as how Expressions can be used to select whether a rule should be applied or not (Selectors). This provides two extension mechanisms that can be used by the additional requirements classes defined in this Standard as well by those introduced in future extension parts: new properties can be added to the Symbolizer class while defining their associated behavior, while new types of Expressions or System Identifiers can also be defined to be used within a Selector Expression or a ParameterValue Expression.

In contrast to the OGC Symbology Core Conceptual Model version 1.0, this version is clarified to not only be defining a conceptual model, but also a specific logical model. This newer version also defines a conceptual and logical model for expressions, which provides one specific mechanism for extension. This Standard clarifies that requirements classes extending this Standard can define additional properties for the Symbolizer class, providing the second extension mechanism. This Standard also includes symbology requirements classes covering the most common use cases for portraying both vector feature data as well as coverage data. Finally, this Standard defines two encodings conforming to the logical model. The more concrete nature of this standard better reflects the fact that it is an OGC Implementation Standard, and recognizes that for rendering engines to implement this Standard and for new or existing encodings to be mapped to the conceptual model of this Standard, the Standard needs to at least cover the essential portrayal use cases. This is demonstrated in a map gallery annex illustrating the various requirements classes coming into play for different use cases of varying complexity. The included encodings for the logical model readily allow to express all of the

symbology capabilities defined in this Standard and should greatly facilitate interoperability and encourage implementation.

In summary, this Standard offers a consistent approach to:

- provide the flexibility required to achieve adequate symbology rules for a variety of information communities; e.g., aviation symbols, weather symbols, thematic maps, etc.; and
- achieve high-level styling interoperability without encoding dependencies, by allowing to define multiple encodings of the same logical model, as well as providing a framework to map the logical models used by other encodings to the one defined in this Standard through the conceptual model that this Standard also defines.

Potential implementations of SymCore are expected to enhance OGC Standards such as the OGC API family of Standards, GeoPackage, the Web Map Service (WMS), Web Feature Service (WFS), and others. By sharing a common core, and using an extension mechanism, integration of these Standards for the purposes of cartographic representation can be greatly simplified.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

## SECURITY CONSIDERATIONS

---

No security considerations have been made for this document.

## SUBMITTING ORGANIZATIONS

---

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

- HEIG-VD (School of Management and Engineering Vaud)
- CNRS (National Center for Scientific Research)
- Strategic ACI
- IGN
- Ecere

## SUBMITTERS

---

All questions regarding this submission should be directed to the editors or the submitters:

| Name                               | Affiliation   |
|------------------------------------|---|
| Olivier Ertz (editor)              | Haute École d'Ingénierie et de Gestion du Canton de Vaud (HEIG-VD)  |
| Erwan Bocher (editor)              | Laboratoire des Sciences et Techniques de l'information de la Communication et de la Connaissance / Centre national de la recherche scientifique (Lab-STICC CNRS) |
| Jérôme Jacovella-St-Louis (editor) | Ecere Corporation   |
| Maxime Collombin (editor)          | Haute École d'Ingénierie et de Gestion du Canton de Vaud (HEIG-VD)  |

1

# SCOPE

---

# SCOPE

This Standard presents the requirements that define version 2.0 of the *Styles and Symbology Model and Encodings – Part 1: Core* ("SymCore 2.0"). A Model for the portrayal of geographic data is defined at both the conceptual and logical levels, in a modular manner through the use of separate requirements classes and specific extension points. The requirements classes defined by this first part cover the most common use cases for portraying geospatial vector features and coverages. Several scenarios of varying complexity and the associated requirements classes enabling them are illustrated in an annex. Two encodings are defined by this Standard: one based on JSON which can be readily parsed with a JSON parser, and another more expressive encoding inspired from Web Cascading Style Sheets (CSS) better suited for hand-editing style sheets. Future parts to this Standard may further extend the portrayal capabilities by defining additional requirements classes.

The *Styles and Symbology Model* is a new approach (Bocher E., Ertz O., 2018, see bibliography):

- to provide the flexibility required to achieve adequate cartographic styling and fill the needs of a variety of information communities; e.g., aviation symbols, weather symbols, thematic maps, etc.; and
- to achieve high level styling interoperability without encoding dependencies.

2

# CONFORMANCE

---

# CONFORMANCE

---

The OGC Styles and Symbology Model and Encodings defines multiple requirements classes and their associated conformance classes.

The standardization target for all conformance classes except the conformance classes defining encodings are both Encodings and Rendering engines. The standardization target for encodings are Rendering Engines and other applications accepting styles as input, as well as applications generating styles (e.g., style editors or converters).

The conformance of all Rendering engines with all conformance classes except the conformance classes defining encodings is with the conceptual model that will result in the expected visual output. The conformance of all Encodings with the conformance classes targeting them can be either at a conceptual level or at a logical level. Conformance at the logical level implies conformance at the conceptual level as well. An Encoding conforms to the logical model if a Style can be encoded using the classes and property names defined in this Standard with only a simple consistent set of rules mapping them to the encoding. An Encoding can conform to the conceptual model of any conformance class either partially (if it can only preserve some of the information) or fully (if it losslessly preserves all information).

The goal is to allow different encodings to have equivalent content and semantics so that they can be interoperable, by establishing a clear mapping from an encoding to the logical and/or conceptual model defined in this Standard. The granularity of conformance classes provides a mechanism to clearly indicate which portrayal capabilities are interoperable with other encodings or rendering engines implementing this Standard. Most Encodings and Rendering engines are expected to easily conform to the requirements classes for basic portrayal.

This document establishes a core requirements class with a URI of <http://www.opengis.net/spec/symbology-1/2.0/req/core>.

Requirements and conformance test URIs defined in this document are relative to <http://www.opengis.net/spec/symbology-1/2.0>.

## 2.1. Requirements classes for basic portrayal

---

### Requirements Class “Core” (<http://www.opengis.net/spec/symbology-1/2.0/req/core>)

The Core Requirements Class specifies requirements that all encodings and rendering engines must support if claiming conformance with this Standard. The Core class defines how a Style is defined as a list of StylingRules consisting of a Symbolizer and an optional Selector expression, as well as a minimal set Symbolizer properties applicable to all types of geospatial data.

### Requirements Class “Basic Vector Features Styling” (<http://www.opengis.net/spec/symbology-1/2.0/req/vector>)

The Basic Vector Features Styling Requirements Class specifies requirements for styling vector features data, including referencing feature properties, specifying a fill and stroke to style vector geometry, as well as defining image, text or dot markers to symbolize points.

**Requirements Class “Basic Coverage Styling”** (<http://www.opengis.net/spec/symbology-1/2.0/req/coverage>)

The Basic Coverage Styling Requirements Class specifies requirements for styling coverage data, including referencing coverage range values (e.g., bands), mapping them to color channels as well as defining colormaps.

**Requirements Class “Basic Labeling”** (<http://www.opengis.net/spec/symbology-1/2.0/req/labels>)

The Basic Labeling Requirements Class specifies requirements for defining labels to be managed by a placement engine and rendered as a final pass on top of the map.

## 2.2. Requirements classes for common portrayal capabilities

---

**Requirements Class “Hill Shading”** (<http://www.opengis.net/spec/symbology-1/2.0/req/hillshading>)

The Hill Shading Requirements Class specifies requirements for styling elevation coverage data with a hill-shaded style.

**Requirements Class “Font Outlines”** (<http://www.opengis.net/spec/symbology-1/2.0/req/fontoutlines>)

The Font Outlines Requirements Class specifies requirements for displaying fonts with outlines so that text can be legible on any background.

**Requirements Class “Hatches, Gradients and Stipples”** (<http://www.opengis.net/spec/symbology-1/2.0/req/hatchesgradientsstipples>)

The Hatches, Gradients and Stipples Requirements Class specifies requirements for defining fills using hatches, gradients or stipples

**Requirements Class “Shape Graphics”** (<http://www.opengis.net/spec/symbology-1/2.0/req/shapegraphics>)

The Shape Graphics Requirements Class specifies requirements for defining geometric shapes which can be used for markers, labels (with Basic Labeling), or as patterns for stroke (with Pattern Strokes) or for fills (with Pattern Fills).

**Requirements Class “Dashes”** (<http://www.opengis.net/spec/symbology-1/2.0/req/dashes>)

The Dashes Requirements Class specifies requirements for defining dashed strokes.

**Requirements Class “Casing and Centerline”** (<http://www.opengis.net/spec/symbology-1/2.0/req/casing>)

The Casing and Centerline Requirements Class specifies requirements for defining strokes with built-in casing and centerline.

## 2.3. Requirements classes for additional expression capabilities

---

**Requirements Class “Parameter Values”** (<http://www.opengis.net/spec/symbology-1/2.0/req/parametervalues>)

The Parameter Values Requirements Class specifies requirements for using an Expression to define any property of a Symbolizer.

**Requirements Class “Right-hand Identifiers”** (<http://www.opengis.net/spec/symbology-1/2.0/req/righthand>)

The Right-hand Identifiers Requirements Class specifies requirements for defining operation expressions with identifiers on the right-hand side.

**Requirements Class “Conditional Expressions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/conditional>)

The Conditional Expressions Requirements Class specifies requirements for defining conditional operation using a ternary [if] ? [then] : [else] structure.

**Requirements Class “Variables”** (<http://www.opengis.net/spec/symbology-1/2.0/req/variables>)

The Variables Requirements Class specifies requirements for defining variables which can be mapped to a dynamic value controlled by an application, or used to facilitate customizing a style.

**Requirements Class “Arithmetic Operators”** (<http://www.opengis.net/spec/symbology-1/2.0/req/arithmetic>)

The Arithmetic Operators Requirements Class specifies requirements for defining arithmetic operation expressions.

**Requirements Class “Bitwise Operators”** (<http://www.opengis.net/spec/symbology-1/2.0/req/bitwise>)

The Bitwise Operators Requirements Class specifies requirements for defining bitwise operation expressions.

**Requirements Class “Text Relation Operators”** (<http://www.opengis.net/spec/symbology-1/2.0/req/textrelation>)

The Text Relation Operators Requirements Class specifies requirements for defining text relation operation expressions.

**Requirements Class “Function Expressions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/functions>)

The Functions Requirements Class specifies requirements for defining function call expressions.

**Requirements Class “Spatial Relation Functions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/spatial>)

The Spatial Relation Requirements Class specifies requirements for standardized spatial relation functions to be used with feature geometry.

**Requirements Class “Temporal Relation Functions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/temporal>)

The Temporal Relation Requirements Class specifies requirements for standardized temporal relation functions to be used with temporal properties.

**Requirements Class “Array Relation Functions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/arrayrelations>)

The Array Relation Requirements Class specifies requirements for standardized array relation functions to be used with array properties.

**Requirements Class “Text Manipulation Functions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/textmanipulation>)

The Text Manipulation Requirements Class specifies requirements for standardized text manipulation functions to be used with text properties.

**Requirements Class “Geometry Manipulation Functions”** (<http://www.opengis.net/spec/symbology-1/2.0/req/geometrymanipulation>)

The Geometry Manipulation Requirements Class specifies requirements for standardized geometry manipulation functions to be used with feature geometry.

## 2.4. Requirements classes for advanced stroke and fills

---

**Requirements Class “Joins and Caps”** (<http://www.opengis.net/spec/symbology-1/2.0/req/joinscaps>)

The Joins and Caps Requirements Class specifies requirements for defining a particular type of join and/or cap on strokes.

**Requirements Class “Pattern Strokes”** (<http://www.opengis.net/spec/symbology-1/2.0/req/patternstrokes>)

The Pattern Strokes Requirements Class specifies requirements for defining pattern strokes using Graphics.

**Requirements Class “Pattern Fills”** (<http://www.opengis.net/spec/symbology-1/2.0/req/patternfills>)

The Pattern Strokes Requirements Class specifies requirements for defining pattern fills using Graphics.

## 2.5. Requirements classes for additional portrayal capabilities

---

**Requirements Class “Shape Outlines”** (<http://www.opengis.net/spec/symbology-1/2.0/req/shapeoutlines>)

The Shape Outlines Requirements Class specifies requirements for displaying shapes with outlines so that they stand out on any background.

**Requirements Class “MultiGraphics and Transforms”** (<http://www.opengis.net/spec/symbology-1/2.0/req/transforms>)

The MultiGraphics and Transforms Requirements Class specifies requirements for building vector graphic hierarchy, including support for arbitrary transforms (translation, rotation and scaling).

**Requirements Class “3D Models and Transforms”** (<http://www.opengis.net/spec/symbology-1/2.0/req/threedim>)

The 3D Models and Transforms Requirements Class specifies requirements for defining 3D model Graphics and 3D transformations.

## 2.6. Requirements classes defining encodings

---

**Requirements Class “JSON Styles and Symbology”** (<http://www.opengis.net/spec/symbology-1/2.0/req/json>)

**Requirements Class “Cascading Cartographic Symbology Style Sheets”** (<http://www.opengis.net/spec/symbology-1/2.0/req/ccsss>)

## 2.7. Declaration of conformance

---

Conformance with this Standard shall be checked using all the relevant tests specified in Annex A (normative) of this document conformance to the respective conformance class is declared using the URIs listed in Table 1. A rendering engine accessible as a Web API can declare conformance to this Standard in its Conformance Declaration response.

The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures ([OGC 08-134r11](#)) and the [OGC Compliance Testing website](#).

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

Full conformance at the conceptual level but not at the logical level, which can losslessly preserve all information of the conceptual model defined in a particular requirements class but necessitates defining a custom mapping and cannot be automated from a simple consistent set of encoding rules, is declared by appending -concept to the conformance URI.

Partial conformance at the conceptual level which can preserve some but not all information of the conceptual model defined in a particular requirements class is declared by appending -partial-concept to the conformance URI.

**Table 1 – Conformance class URIs**

| CONFORMANCE CLASS               | URI   |
|---------------------------------|---|
| Core                            | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/core">http://www.opengis.net/spec/symbology-1/2.0/conf/core</a>   |
| Basic Vector Features Styling   | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/vector">http://www.opengis.net/spec/symbology-1/2.0/conf/vector</a>                                     |
| Basic Coverage Styling          | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/coverage">http://www.opengis.net/spec/symbology-1/2.0/conf/coverage</a>                                 |
| Basic Labeling                  | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/labels">http://www.opengis.net/spec/symbology-1/2.0/conf/labels</a>                                     |
| Hill Shading                    | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/hillshading">http://www.opengis.net/spec/symbology-1/2.0/conf/hillshading</a>                           |
| Font Outlines                   | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/fontoutlines">http://www.opengis.net/spec/symbology-1/2.0/conf/fontoutlines</a>                         |
| Hatches, Gradients and Stipples | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/hatchesgradientsstipples">http://www.opengis.net/spec/symbology-1/2.0/conf/hatchesgradientsstipples</a> |
| Shape Graphics                  | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/shapegraphics">http://www.opengis.net/spec/symbology-1/2.0/conf/shapegraphics</a>                       |
| Dashes                          | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/dashes">http://www.opengis.net/spec/symbology-1/2.0/conf/dashes</a>                                     |

| CONFORMANCE CLASS               | URI   |
|---------------------------------|---|
| Casing and Centerline           | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/casing">http://www.opengis.net/spec/symbology-1/2.0/conf/casing</a>                             |
| Parameter Values                | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/parametervalues">http://www.opengis.net/spec/symbology-1/2.0/conf/parametervalues</a>           |
| Function Expressions            | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/functions">http://www.opengis.net/spec/symbology-1/2.0/conf/functions</a>                       |
| Spatial Relation Functions      | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/spatial">http://www.opengis.net/spec/symbology-1/2.0/conf/spatial</a>                           |
| Temporal Relation Functions     | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/temporal">http://www.opengis.net/spec/symbology-1/2.0/conf/temporal</a>                         |
| Array Relation Functions        | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/arrayrelations">http://www.opengis.net/spec/symbology-1/2.0/conf/arrayrelations</a>             |
| Text Manipulation Functions     | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/textmanipulation">http://www.opengis.net/spec/symbology-1/2.0/conf/textmanipulation</a>         |
| Geometry Manipulation Functions | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/geometrymanipulation">http://www.opengis.net/spec/symbology-1/2.0/conf/geometrymanipulation</a> |
| Arithmetic Operators            | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/arithmetic">http://www.opengis.net/spec/symbology-1/2.0/conf/arithmetic</a>                     |
| Bitwise Operators               | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/bitwise">http://www.opengis.net/spec/symbology-1/2.0/conf/bitwise</a>                           |
| Text Relation Operators         | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/textrelation">http://www.opengis.net/spec/symbology-1/2.0/conf/textrelation</a>                 |
| Right-hand Identifiers          | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/righthand">http://www.opengis.net/spec/symbology-1/2.0/conf/righthand</a>                       |
| Conditional Expressions         | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/conditional">http://www.opengis.net/spec/symbology-1/2.0/conf/conditional</a>                   |
| Variables                       | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/variables">http://www.opengis.net/spec/symbology-1/2.0/conf/variables</a>                       |
| Joins and Caps                  | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/joinscaps">http://www.opengis.net/spec/symbology-1/2.0/conf/joinscaps</a>                       |
| Pattern Strokes                 | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/patternstrokes">http://www.opengis.net/spec/symbology-1/2.0/conf/patternstrokes</a>             |
| Pattern Fills                   | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/patternfills">http://www.opengis.net/spec/symbology-1/2.0/conf/patternfills</a>                 |
| Shape Outlines                  | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/shapeoutlines">http://www.opengis.net/spec/symbology-1/2.0/conf/shapeoutlines</a>               |
| MultiGraphics and Transforms    | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/transforms">http://www.opengis.net/spec/symbology-1/2.0/conf/transforms</a>                     |
| 3D Models and Transforms        | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/threedim">http://www.opengis.net/spec/symbology-1/2.0/conf/threedim</a>                         |
| JSON Styles and Symbology       | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/json">http://www.opengis.net/spec/symbology-1/2.0/conf/json</a>                                 |

**CONFORMANCE CLASS****URI**

Cascading Cartographic  
Symbology Style Sheets

<http://www.opengis.net/spec/symbology-1/2.0/conf/ccsss>

3

# NORMATIVE REFERENCES

---

## NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Jeff de La Beaujardiere: OGC 06-042, *OpenGIS Web Map Service (WMS) Implementation Specification*. Open Geospatial Consortium (2006). [https://portal.ogc.org/files/?artifact\\_id=14416](https://portal.ogc.org/files/?artifact_id=14416).

Markus Lupp: OGC 05-078r4, *OpenGIS Styled Layer Descriptor Profile of the Web Map Service Implementation Specification*. Open Geospatial Consortium (2007). [https://portal.ogc.org/files/?artifact\\_id=22364](https://portal.ogc.org/files/?artifact_id=22364).

Dr. Markus Mueller: OGC 05-077r4, *OpenGIS Symbology Encoding Implementation Specification*. Open Geospatial Consortium (2007). [https://portal.ogc.org/files/?artifact\\_id=16700](https://portal.ogc.org/files/?artifact_id=16700).

Panagiotis (Peter) A. Vretanos: OGC 09-026r2, *OGC Filter Encoding 2.0 Encoding Standard – With Corrigendum*. Open Geospatial Consortium (2014). <https://docs.ogc.org/is/09-026r2/09-026r2.html>.

Policy SWG: OGC 08-131r3, *The Specification Model – Standard for Modular specifications*. Open Geospatial Consortium (2009). [https://portal.ogc.org/files/?artifact\\_id=34762&version=2](https://portal.ogc.org/files/?artifact_id=34762&version=2).

A. Phillips, M. Davis: IETF RFC 4646, *Tags for Identifying Languages*. RFC Publisher (2006). <https://www.rfc-editor.org/info/rfc4646>.

ISO: ISO 19117:2012, *Geographic information – Portrayal*. International Organization for Standardization, Geneva (2012). <https://www.iso.org/standard/46226.html>.

*The Unified Code for Units of Measure (UCUM)*, 2017 <http://unitsofmeasure.org/ucum.html>

W3C css-fonts-3, *CSS Fonts Module Level 3*. <https://www.w3.org/TR/css-fonts-3/>.

Panagiotis (Peter) A. Vretanos: OGC Common Query Language (CQL2) (Draft). OGC 21-065, Open Geospatial Consortium, <http://docs.ogc.org/DRAFTS/21-065.html>

4

# TERMS AND DEFINITIONS

---

# TERMS AND DEFINITIONS

---

This document uses the terms defined in [OGC Policy Directive 49](#), which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word "shall" (not "must") is the verb form used to indicate a requirement to be strictly followed to conform to this document and OGC documents do not use the equivalent phrases in the ISO/IEC Directives, Part 2.

This document also uses terms defined in the OGC Standard for Modular specifications ([OGC 08-131r3](#)), also known as the 'ModSpec'. The definitions of terms such as standard, specification, requirement, and conformance test are provided in the ModSpec.

For the purposes of this document, the following additional terms and definitions apply.

For the purposes of this document, the following terms and definitions apply.

This document used the terms defined in Policy Directive 492, which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word "shall" (not "must") is the verb form used to indicate a requirement to be strictly followed to conform to this standard and OGC documents do not use the equivalent phrases in the ISO/IEC Directives, Part 2.

This document also uses terms defined in the OGC Standard for Modular specifications ([OGC 08-131r3](#)), also known as the 'ModSpec'. The definitions of terms such as standard, specification, requirement, and conformance test are provided in the ModSpec.

For the purposes of this document, the following additional terms and definitions apply.

## 4.1. Portrayal

---

Presentation of information to humans (Note 1 to entry: Within the scope of this International Standard, portrayal is restricted to the portrayal of geographic information). [SOURCE: ISO 19117:2012, 4.20]

## 4.2. Layer

---

Abstraction of reality specified by a geographic data model (feature, coverage...). A layer may be represented using a set of symbols (Style). A layer contributes to a single geographic subject and may be a theme.

## **4.3. Style**

---

A sequence of rules of symbolizing instructions to be applied by a rendering engine on one or more features and/or coverages.

## **4.4. Rendering engine**

---

Automated process that produces graphics using a pipeline of layers and styles as inputs.

## **4.5. Render**

---

Conversion of digital graphics data into visual form (EXAMPLE Generation of an image on a video display) [SOURCE: ISO 19117:2012, 4.27]

5

# CONVENTIONS

---

# CONVENTIONS

This section provides details and examples for any conventions used in the document. Examples of conventions are symbols, abbreviations, use of XML schema, or special notes regarding how to read the document.

## 5.1. Abbreviated terms

The abbreviated terms clause gives a list of the abbreviated terms necessary for understanding this document.

IETF Internet Engineering Task Force, <https://ietf.org/>

ISO International Organization for Standardization, <https://www.iso.org>

OGC Open Geospatial Consortium, [www.opengeospatial.org](http://www.opengeospatial.org)

UML Unified Modeling Language, <http://www.uml.org/>

6

# OVERVIEW

---

This Standard defines conformance classes for:

- a core symbology conceptual and logical model based on Styles as a list of StylingRules consisting of a Symbolizer and optional Selector Expression (Section 7),
- additional conformance classes extending this core model with:
  - basic portrayal capabilities of vector features (Section 8),
  - portrayal capabilities of coverage data (Section 9),
  - label placement and font outlines capabilities (Section 10),
  - shape graphics capabilities including circles, ellipses, arcs, rectangles (including rounded rectangles) and paths (polylines and polygons), with the ability to use outlines (Section 11),
  - vector graphic hierarchy capabilities, including full 2D transforms (Section 12),
  - advanced strokes capabilities, including specific joins and caps, dashed lines, casing and centerlines, and graphic patterns (Section 13),
  - advanced fill capabilities, including graphic patterns, hatches, gradients and stipbles (Section 14),
  - using expressions as parameter values for any symbolizer properties (Section 15),
  - using identifiers in the right side of operation expressions, conditional expressions and variables (Section 16),
  - arithmetic, bitwise and text relation operators (Section 17),
  - function call expressions and standardized functions for spatial, temporal and array relations, as well as text and geometry manipulation (Section 18), and
  - using 3D model graphics and 3D transforms (Section 19),
- two encodings for the logical and conceptual model covering all of these conformance classes:
  - an encoding based on JSON that can be readily parsed by JSON parser (Section 20), and
  - a more expressive encoding based on Web CSS which is better suited to hand-edit styles (Section 21).

In addition, the following annexes are included:

- a normative Abstract Test Suite for the conformance classes (Annex A),
- an informative mapping of SLD/SE and notable vendor extensions to the conceptual model and requirements classes (Annex B),
- an informative map gallery of practical use cases alongside the styles used to generate the maps encoded in the *Cascading Cartographic and Symbology Style Sheets* encoding (Annex C), and
- an informative revision history (Annex D).

7

# REQUIREMENTS CLASS “CORE”

---

# REQUIREMENTS CLASS “CORE”

## 7.1. Overview

The requirements described in this section define the symbology core requirement class. The following UML diagram (Figure 1) shows the fundamental concepts of the Symbology Conceptual and Logical Model:

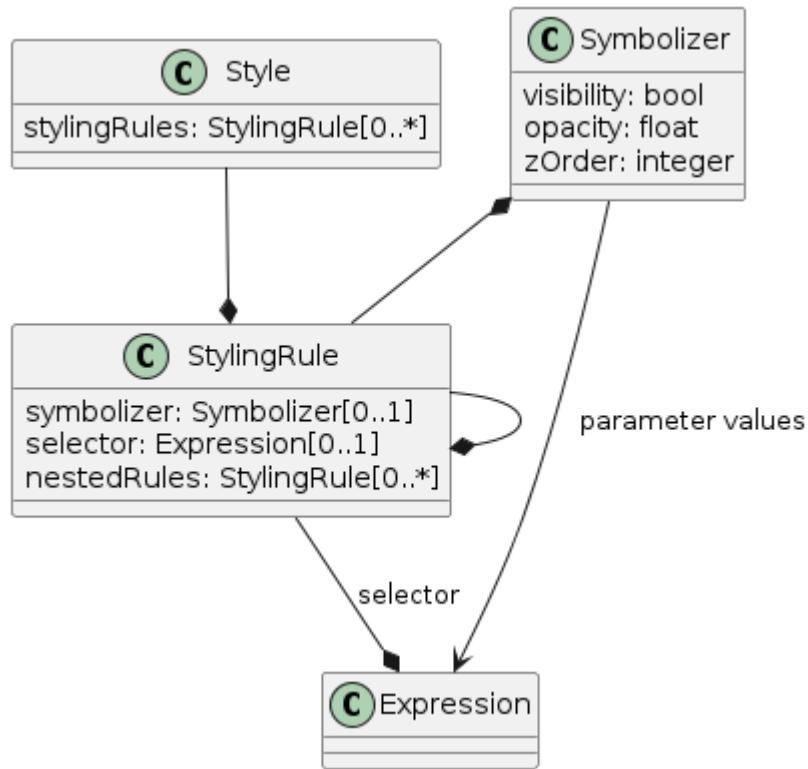


Figure 1 – Symbology Core Classes UML Diagram

### 7.1.1. Styles

A Style is the root concept of the Styles and Symbology Conceptual Model and consists of an ordered list of StylingRules. The StylingRules are to be applied in order so that rules selected later override earlier ones. This allows to compose styles in a cascading manner by inheriting from a base style then overriding some specific portrayal behaviors.

**Table 2 – Style class**

| NAME         | DEFINITION                       | DATA TYPE AND VALUE | MULTIPLICITY |
|--------------|----------------------------------|---------------------|--------------|
| stylingRules | Styling rules defining the style | StylingRule         | 0..*         |

### 7.1.2. Styling Rules

A StylingRule specifies that a particular Symbolizer (defining how to portray data) should be applied if the rule is selected based on a Selector expression (e.g., feature-property conditions or map scales). A StylingRule can contain nested rules, which will only be applied if the parent rule's Selector is evaluated to true, and whose Symbolizers will inherit from and override the parent StylingRule's Symbolizer.

**Table 3 – StylingRule**

| NAME         | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|--------------|--|---------------------|--------------|
| name         | A name for the rule (useful for generating legends)            | string              | 0..1         |
| selector     | Selector defining the condition to apply the rule's symbolizer | Expression          | 0..1         |
| symbolizer   | Symbolize(s) to apply by the rendering engine                  | Symbolizer          | 1            |
| nested Rules | Symbolize(s) to apply by the rendering engine                  | StylingRule         | 0..*         |

The selector (also sometimes called a *filter*), for the rule is defined as a predicate expression evaluating to either true or false.

### 7.1.3. Symbolizers

A Symbolizer describes how to portray geographic data (e.g., vector features or gridded coverage data) based on a set of properties. This core requirements class only defines three basic properties relevant to most portrayal use cases. Separate requirements classes and later parts will extend this Symbolizer class with additional properties to provide more advanced portrayal capabilities.

**Table 4 – Symbolizer class**

| NAME       | DEFINITION                  | DATA TYPE AND VALUE | MULTIPLICITY |
|------------|-----------------------------|---------------------|--------------|
| visibility | Whether to display the data | bool                | 0..1         |

| NAME    | DEFINITION                | DATA TYPE AND VALUE | MULTIPLICITY |
|---------|---------------------------|---------------------|--------------|
| opacity | Degree of opacity         | float               | 0..1         |
| zOrder  | Specify a rendering order | int                 | 0..1         |

### 7.1.4. Expressions

Expressions are a syntactic entity that may be evaluated to determine its value (from [Wikipedia](#)). The concept has similar meaning to Expressions as defined in the OGC Filter Encoding 2.0 standard, and can also be implemented with the OGC Common Query Language (CQL2), with the caveat that the Expressions defined here are not restricted to evaluate to a boolean value as is the case for the first version of CQL2.

Expressions can be used in two places according to this Styles & Symbology conceptual model: as a Selector defining the condition whether to apply a StylingRule or not, as well as to define the values of Symbolizer properties.



Figure 2 – Expression Classes UML Diagram

#### 7.1.4.1. Parameter Values

The use of an expression as a Symbolizer property is called a *Parameter Value*, where an Expression can be substituted where a particular data type is expected, in which case the Expression will be resolved to that expected data type. Conceptually, all Symbolizer properties can be specified using any type of expression *Parameter Value*, but this is not required by this core conformance class, and specific requirements classes such as the “Symbolizer Parameter Value Expressssions” requirements class enable this behavior. Without a requirements class specifying otherwise, only Literal Expressions compatible with the expected data type are allowed as *Parameter Values*.

#### 7.1.4.2. Identifier Expressions

An Identifier Expression is represented by a textual property that gets resolved at runtime.

Typical example of identifier expressions include feature properties (e.g., population) and coverage range values (e.g., a particular imagery band B8).

#### 7.1.4.2.1. System Identifiers

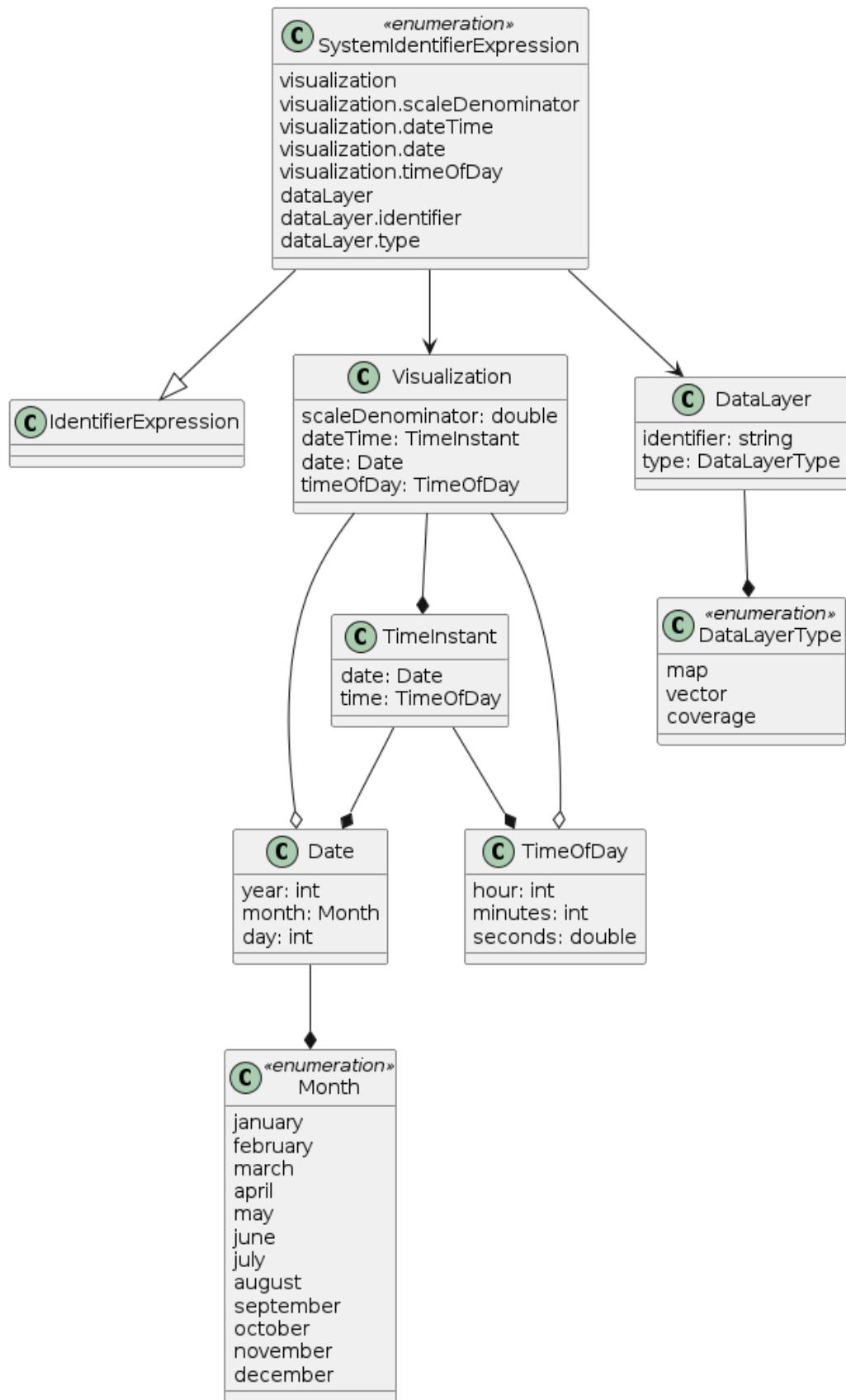


Figure 3 – System Identifiers UML Diagram

One specific type of identifier expressions use System Identifiers. A System Identifier refers to an internal state of the system, or a particular aspect of the data being portrayed.

The following System Identifiers are defined by this conformance class:

**Table 5 – Visualization System Identifiers**

| NAME                           | DEFINITION                              | DATA TYPE AND VALUE |
|--------------------------------|---|---------------------|
| visualization.scaleDenominator | Current visualization scale denominator | float               |
| visualization.dateTime         | Current visualization date and time     | DateTime            |
| visualization.date             | Current visualization date              | Date                |
| visualization.timeOfDay        | Current visualization time of day       | Time                |

**Table 6 – Layer System Identifiers**

| NAME                 | DEFINITION                | DATA TYPE AND VALUE                |
|----------------------|---------------------------|------------------------------------|
| dataLayer.identifier | Identifier of data layers | string                             |
| dataLayer.type       | Data type of data layers  | enumeration: vector, coverage, ... |

**Table 7 – Month enumeration**

| NAME     |
|----------|
| january  |
| february |
| march    |
| april    |
| may      |
| june     |
| july     |

| NAME      |
|-----------|
| august    |
| september |
| october   |
| november  |
| december  |

**Table 8 – Date class**

| NAME  | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|-------|------------|---------------------|--------------|
| year  |            | int                 | 1            |
| month |            | Month               | 1            |
| day   |            | int                 | 1            |

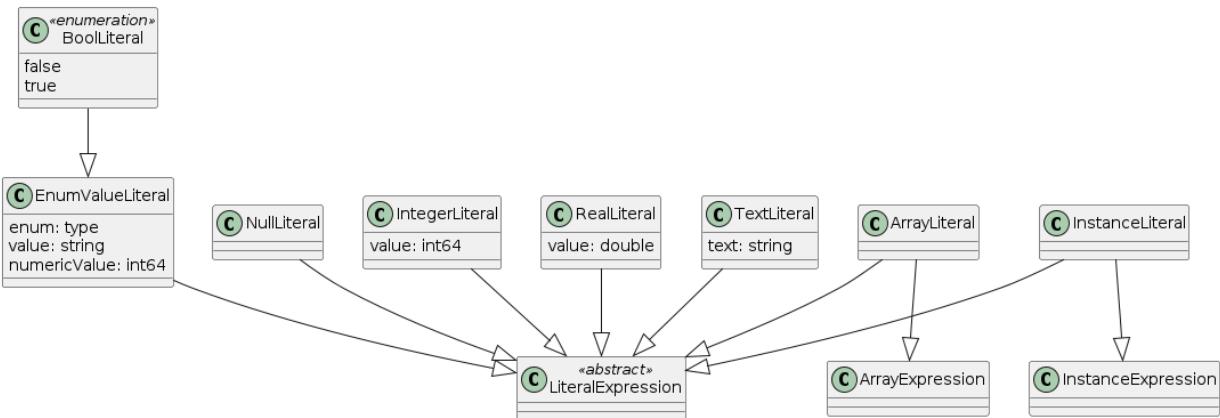
**Table 9 – TimeOfDay class**

| NAME    | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|---------|------------|---------------------|--------------|
| hour    |            | int                 | 1            |
| minutes |            | Month               | 1            |
| seconds |            | int                 | 1            |

**Table 10 – Class TimelInstant**

| NAME | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|------|------------|---------------------|--------------|
| date |            | Date                | 1            |
| time |            | TimeOfDay           | 1            |

### 7.1.4.3. Literal Expressions



**Figure 4 – Literal Classes UML Diagram**

A literal expression is an expression that has a fixed value in the encoding of the style. A similar literal class concept was originally defined in the OGC Filter Encoding 2.0 standard section 7.5.1.

The following types of literals are defined:

- An integer literal represents a whole numeric value
- A real literal represents a real number (integer, fractional or irrational number)
- Text literals are Unicode character strings
- A null literal represents an unset value
- Enumeration value literals allow to refer by name to a set of pre-defined values associated with the context where they are used
- Boolean literals are a specialized type of enumeration literals which are either true or false
- Array literals (see Array Expressions)
- Instance literals (see Instance Expressions)

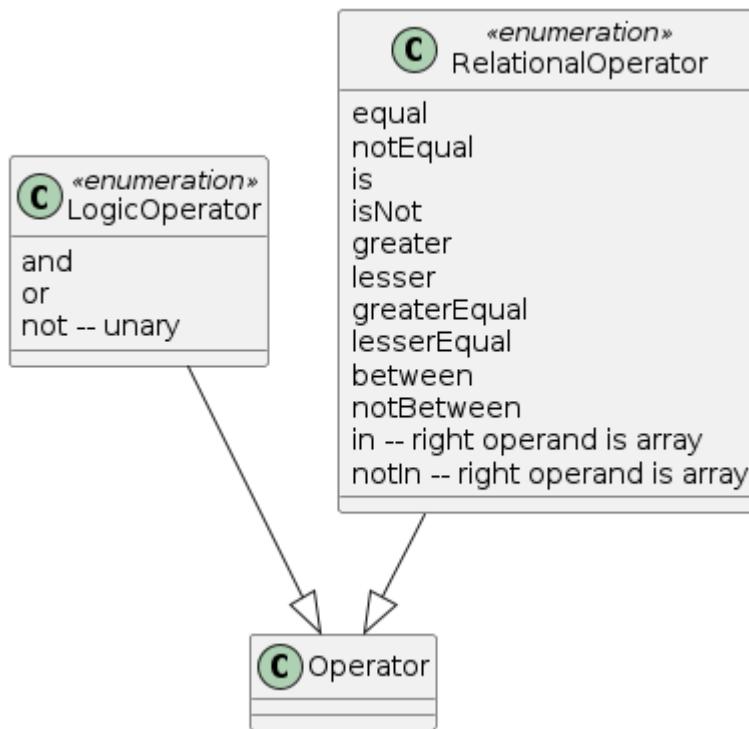
### 7.1.4.4. Operation Expressions

An Operation Expression performs an operation specified by an Operator on one, two or three operand expressions, depending on whether they unary, binary or ternary operators. This core requirements class defines only Logical and Relational operators. Implementations are also required to support prioritizing operations (typically encoded using parentheses: ( )). Other requirements classes introduce support for additional operators for arithmetic, text and bitwise

operations. Without support for the *Any right-hand operand* requirements class, the right-hand operands of RelationExpressions are limited to LiteralExpressions.

**Table 11** – OperationExpression class

| NAME     | DEFINITION     | DATA TYPE AND VALUE | MULTIPLICITY |
|----------|----------------|---------------------|--------------|
| operand1 | First operand  | Expression          | 0..1         |
| operator | Operator       | Operator            | 1            |
| operand2 | Second operand | Expression          | 1            |



**Figure 5** – Core Logic and Relational Operators UML Diagram

This requirements class defines the following Logical Operators :

**Table 12** – Logical Operators

| NAME | SYMBOL | TYPE   | DEFINITION                                 |
|------|--------|--------|--|
| not  | not    | unary  | True if and only if the operand is false   |
| and  | and    | binary | True if and only if both operands are true |

| NAME | SYMBOL | TYPE   | DEFINITION   |
|------|--------|--------|--|
| or   | or     | binary | True if and only if either or both of the operands is true |

This requirements class defines the following Relational Operators:

**Table 13 – Relational Operators**

| NAME            | SYMBOL              | TYPE    | DEFINITION   |
|-----------------|---------------------|---------|--|
| equalTo         | =                   | binary  | The first operand is equal to the second one   |
| notEqualTo      | <>                  | binary  | The first operand is not equal to the second one   |
| is (null)       | is                  | binary  | Only used with null literal for second operand (the first operand is null)                             |
| isNot (null)    | is not              | binary  | Only used with null literal for second operand (the first operand is not null)                         |
| smallerThan     | <                   | binary  | The first operand is smaller than the second one   |
| greaterThan     | >                   | binary  | The first operand is greater than the second one   |
| smaller OrEqual | <=                  | binary  | The first operand is smaller than or equal to the second one   |
| greater OrEqual | >=                  | binary  | The first operand is greater than or equal to the second one   |
| in (array)      | in                  | binary  | Only used with an array for second operand (the first operand is one of the elements of the array)     |
| notIn (array)   | not in              | binary  | Only used with an array for second operand (the first operand is not one of the elements of the array) |
| between         | between ... and     | ternary | The first operand is between the second and third operands (inclusively)                               |
| notBetween      | not between ... and | ternary | The first operand is not between the second and third operands (inclusively)                           |

#### 7.1.4.5. Array Expressions

An array expressions defines zero, one, or more element expressions forming an ordered set.

An *array literal* is a special type of array expression whose elements are all literals.

#### 7.1.4.6. Instance Expressions

An instance expression instantiates an object of a class while optionally specifying values for member components. The default values for any member if not explicitly overridden can be specified by the class member definitions.

An *instance literal* is a special type of instance expression assigning only literal expressions to its member components.

A Symbolizer may either set an object property with a complete new instance, or specifically override a particular member of that object property. This capability is particularly useful when using nested StylingRules, where a nested rule can inherit the Symbolizer from the parent StylingRule.

## 7.2. Requirements

---

### 7.2.1. Core

#### REQUIREMENTS CLASS 1: CORE

**IDENTIFIER** <http://www.opengis.net/spec/symbology-1/2.0/req/core>

**TARGET TYPE** Style encodings and Renderers

#### 7.2.1.1. Style **stylingRules** property

#### REQUIREMENT 1

**IDENTIFIER** /req/core/rules

**A** An Encoding SHALL support individually storing and preserving the order of each StylingRule constituting a Style.

**B** A Renderer SHALL support considering in order each individual StylingRule constituting a style.

**C** The Symbolizer properties specified in a StylingRule appearing later in a Style's list of rules and whose Selector evaluates to true SHALL be interpreted as overriding all Symbolizer properties set by earlier rules.

#### 7.2.1.2. StylingRule **nestedRules** property

##### REQUIREMENT 2

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/nested              |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

#### 7.2.1.3. Identifier Expressions

##### REQUIREMENT 3

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/expressions         |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

#### 7.2.1.4. StylingRule **selector** property

##### REQUIREMENT 4

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/selector            |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

#### 7.2.1.5. StylingRule **symbolizer** property

## REQUIREMENT 5

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/symbolizer          |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

### 7.2.1.6. Symbolizer properties Parameter Values

## REQUIREMENT 6

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/parameters          |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

### 7.2.1.7. Symbolizer visibility property

## REQUIREMENT 7

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/visibility          |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

### 7.2.1.8. Symbolizer opacity property

## REQUIREMENT 8

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core-opacity             |
| A          | An Encoding SHALL support ... |

## REQUIREMENT 8

B A Renderer SHALL support ...

### 7.2.1.9. Symbolizer zorder property

## REQUIREMENT 9

IDENTIFIER /req/core/zorder

A An Encoding SHALL support ...

B A Renderer SHALL support ...

### 7.2.1.10. Literal Expressions

## REQUIREMENT 10

IDENTIFIER /req/core/literals

A An Encoding SHALL support ...

B A Renderer SHALL support ...

### 7.2.1.11. Identifier Expressions

## REQUIREMENT 11

IDENTIFIER /req/core/identifiers

A An Encoding SHALL support ...

B A Renderer SHALL support ...

#### 7.2.1.12. Visualization Scale Denominator System Identifiers

##### REQUIREMENT 12

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/scale               |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

#### 7.2.1.13. Visualization Time System Identifiers

##### REQUIREMENT 13

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/time                |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

#### 7.2.1.14. Data Layer System Identifiers

##### REQUIREMENT 14

|            |                               |
|------------|-------------------------------|
| IDENTIFIER | /req/core/layers              |
| A          | An Encoding SHALL support ... |
| B          | A Renderer SHALL support ...  |

#### 7.2.1.15. Operation Expressions

## REQUIREMENT 15

IDENTIFIER /req/core/operations

- A An Encoding SHALL support defining operation expressions consisting of operands and an operator for unary, binary and ternary operators.
- B An Encoding SHALL support defining the priority of expressions using multiple operators (e.g., using parentheses: ( )).
- C A Renderer SHALL support evaluating operation expressions while respecting the priority of operations.

### 7.2.1.16. Logical Operation Expressions

## REQUIREMENT 16

IDENTIFIER /req/core/logical

- A An Encoding SHALL support ...
- B A Renderer SHALL support ...

### 7.2.1.17. Relational Operation Expressions

## REQUIREMENT 17

IDENTIFIER /req/core/relational

- A An Encoding SHALL support ...
- B A Renderer SHALL support ...

### 7.2.1.18. Array Expressions

## REQUIREMENT 18

IDENTIFIER /req/core/arrays

## REQUIREMENT 18

A An Encoding SHALL support ...

B A Renderer SHALL support ...

### 7.2.1.19. Instance Expressions

## REQUIREMENT 19

IDENTIFIER /req/core/instances

A An Encoding SHALL support ...

B A Renderer SHALL support ...

8

# REQUIREMENTS CLASS “BASIC VECTOR FEATURES STYLING”

---

# REQUIREMENTS CLASS “BASIC VECTOR FEATURES STYLING”

---

## 8.1. Overview

---

This requirements class adds support for defining how to Fill and render the Stroke of vector geometry. In addition, it defines the ability to specify a Marker consisting of one or more Graphic, to be rendered at the exact location of point geometry, at the centroid of polygon geometry, or at each point of line geometry.

### 8.1.1. Symbolizer extension for vector features



**Figure 6 – Basic Vector Features Extended Symbolizer Class UML Diagram**

The following three new Symbolizer properties are defined by this requirements class:

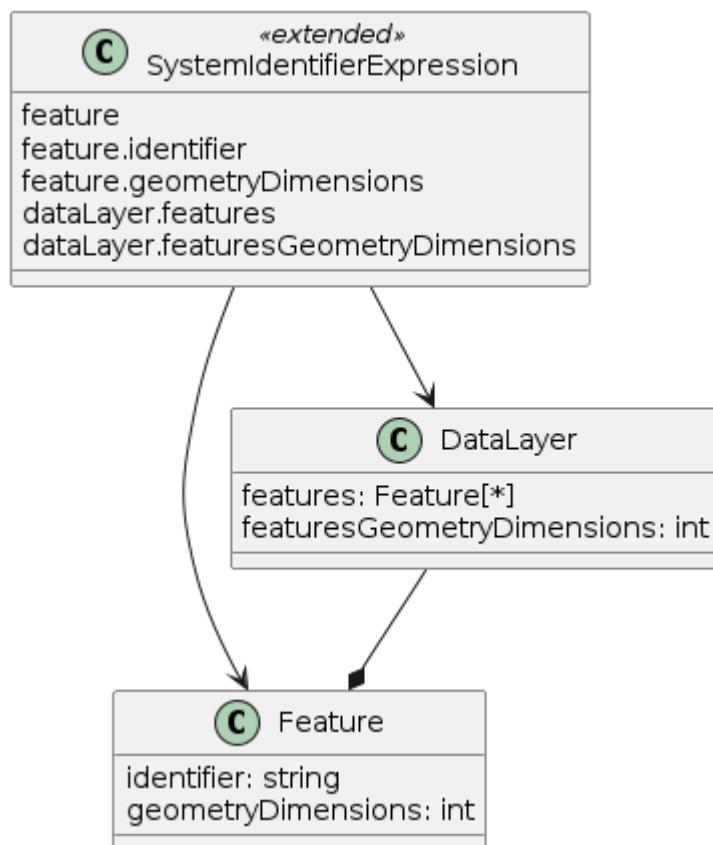
**Table 14 – Symbolizer class (vector features extension)**

| NAME   | DEFINITION   | DATA TYPE AND<br>VALUE | MULTIPLICITY |
|--------|--|------------------------|--------------|
| fill   | Fill to fill inside of geometries                                | Fill                   | 0..1         |
| stroke | Stroke to render geometry outlines                               | Stroke                 | 0..1         |
| marker | Marker to render at geometries points or centroid (for polygons) | float                  | 0..1         |

## 8.1.2. Extended Identifiers for vector features

This requirements class defines as valid identifiers all of the accessible properties for a feature being portrayed with the name of those properties being the text of the identifier. Those identifiers are to be resolved with the value of that property. An encoding must support an escaping mechanism in cases where the name of a feature property might clash with a syntactic element.

### 8.1.2.1. Extended System Identifiers



**Figure 7 – Vector Features System Identifiers UML Class Diagram**

In addition, the following new System Identifiers are defined by this requirements class:

**Table 15 – System identifiers for vector features**

| NAME               | DEFINITION                         | DATA TYPE AND VALUE |
|--------------------|------------------------------------|---------------------|
| feature.identifier | Identifier of a particular feature | string or number    |

| NAME                                 | DEFINITION   | DATA TYPE AND VALUE  |
|--------------------------------------|--|--|
| feature.geometryDimensions           | Dimension of geometry for a particular feature           | 0 (points), 1 (lines), 2 (polygons), 3 (polyhedrons)               |
| dataLayer.featuresGeometry Dimension | Dimension of feature geometry (if same for all features) | 0 (points), 1 (lines), 2 (polygons), 3 (polyhedrons), null (mixed) |

### 8.1.3. Colors



**Figure 8 – Color class UML Diagram**

Both the Fill and Stroke allow to define a Color, specified using red, green and blue components. The ability to define Colors in other spaces (e.g., Lab, CMYK) is defined in separate requirements classes and applies wherever this basic RGB Color class is used.

**Table 16 – Color class**

| NAME | DEFINITION      | TYPE  | MULTIPLICITY |
|------|-----------------|-------|--------------|
| r    | Red component   | float | 1            |
| g    | Green component | float | 1            |
| b    | Blue component  | float | 1            |

### 8.1.4. Fills



**Figure 9 – UML Class Diagram of the Symbology Fill**

A Fill defines the graphical symbolizing parameters required to draw the filling of a two-dimensional shape such as a polygon. Separate conformance classes can extend this Fill class with additional properties.

**Table 17 – Fill class**

| NAME    | DEFINITION          | TYPE  | MULTIPLICITY |
|---------|---------------------|-------|--------------|
| color   | Color of the fill   | Color | 0..1         |
| opacity | Opacity of the fill | float | 0..1         |

### 8.1.5. Strokes



**Figure 10 – Stroke Class UML Diagram**

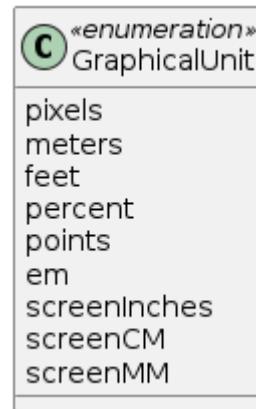
A *Stroke* defines the graphical symbolizing parameters for drawing an outline (e.g., for linear geometries or the exterior of a polygon geometry). As an abstract class and part of the base of the core graphical concepts, *StrokeClass* is a global point of extension to specify concrete ways to draw outlines (e.g., the *PenStroke* and *GraphicStroke* extensions). The *StrokeClass* properties are documented in the following table.

A *Stroke* object inherits from a base *StrokeStyling* class, which is re-used in a separate requirements class for defining more complex strokes:

**Table 18 – StrokeStyling class**

| NAME  | DEFINITION          | DATA TYPE AND VALUE   | MULTIPLICITY |
|-------|---------------------|-----------------------|--------------|
| color | Color of the stroke | Color                 | 0..1         |
| width | Width of the stroke | float (uom-qualified) | 0..1         |

### 8.1.5.1. Graphical Units of Measure



**Figure 11** – Graphical Units Enumeration UML Diagram

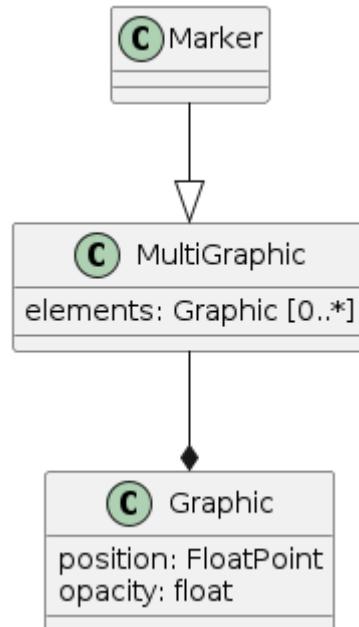
For styling parameters that define sizing and positioning of graphical objects (width, displacement, etc.), a specific the unit of measure needs to be provided for the rendering engine. Therefore, properties where a unit of measure is relevant can be qualified with a particular uom codes.

Below is the list of allowed units of measure as per UCUM (except for pixel):

- portrayal units: pixel, millimeter, inch, percentage; and
- ground units: meter, foot.

The portrayal unit “pixel” is the default unit of measure. If available, the pixel size depends on the viewer client resolution, otherwise it is equal to 0.28mm x 0.28mm (~ 90 DPI).

## 8.1.6. Markers



**Figure 12 – Marker Class UML Diagram**

A Marker inherits from a MultiGraphic which can contain multiple graphical elements:

**Table 19 – MultiGraphic class**

| NAME     | DEFINITION        | DATA TYPE AND VALUE | MULTIPLICITY |
|----------|-------------------|---------------------|--------------|
| elements | Children elements | Graphic             | 1..*         |

Without support for the *Multi Graphics and Transforms* requirements class, a MultiGraphic cannot contain another MultiGraphic.

A MultiGraphic itself inherits from a Graphic allowing to specify an opacity and a 2D position:

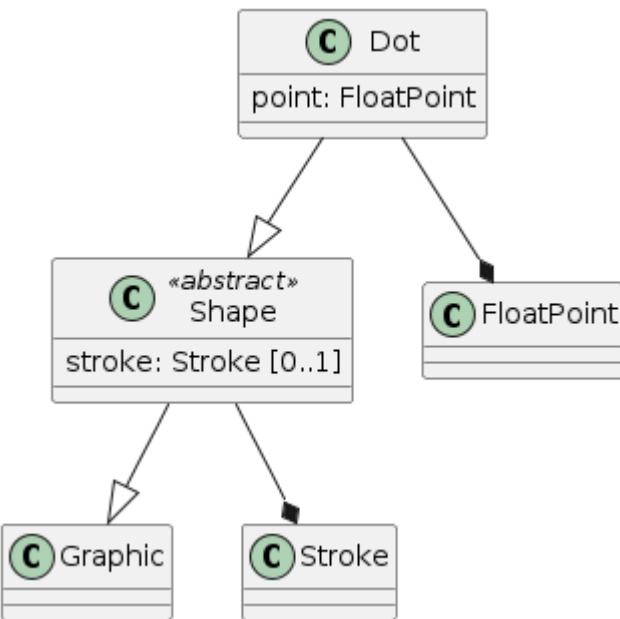
**Table 20 – Graphic class**

| NAME     | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|----------|------------|---------------------|--------------|
| opacity  | Opacity    | float               | 0..1         |
| position | Position   | FloatPoint          | 0..1         |

**Table 21 – FloatPoint class**

| NAME | DEFINITION          | DATA TYPE AND VALUE   | MULTIPLICITY |
|------|---------------------|-----------------------|--------------|
| x    | Horizontal position | float (uom-qualified) | 1            |
| y    | Vertical position   | float (uom-qualified) | 1            |

### 8.1.6.1. Dot Graphics

**Figure 13 – Dot Class UML Diagram**

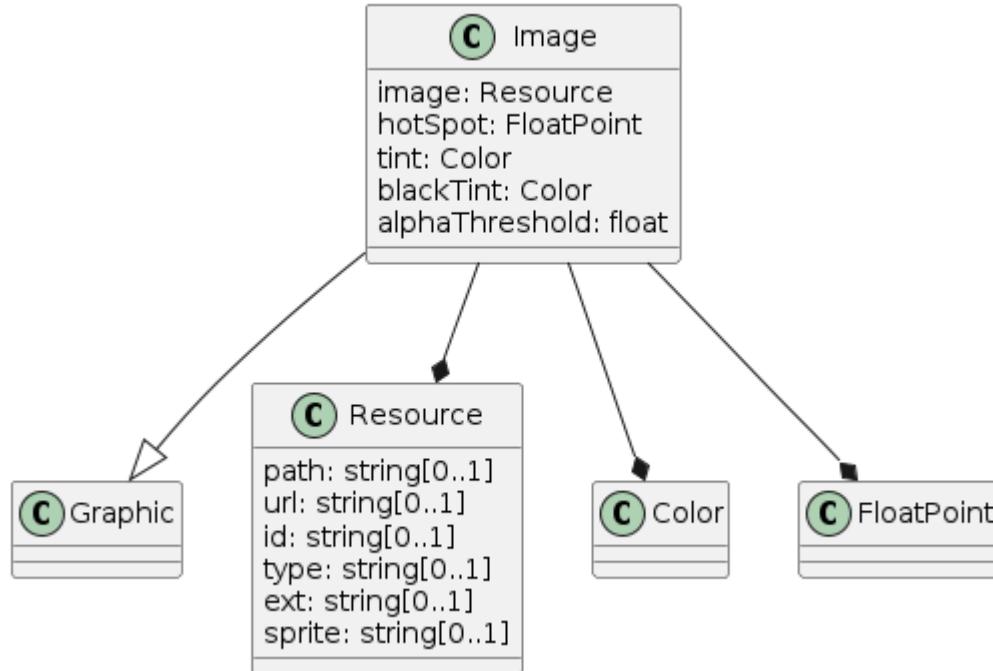
A round Dot is one type of Graphic defined by this requirements class that can be used as part of a Marker.

A Dot inherits from a Shape class allowing to define a stroke which controls the color and size of the dot (with the stroke's width property).

**Table 22 – Shape**

| NAME   | DEFINITION                                    | TYPE   | MULTIPLICITY |
|--------|---|--------|--------------|
| stroke | Stroke with which to render the shape outline | Stroke | 0..1         |

### 8.1.6.2. Image Graphics



**Figure 14 – Image Class UML Diagram**

An Image is one type of graphic defined by this requirements class that can be used as part of a Marker.

**Table 23 – Image**

| NAME           | DEFINITION                      | TYPE                       | MULTIPLICITY |
|----------------|---------------------------------|----------------------------|--------------|
| image          | The image to use                | Resource                   | 1            |
| hotSpot        | 0,0 position in the image       | FloatPoint (uom-qualified) | 1            |
| tint           | Tint (multiplying white)        | Color                      | 1            |
| blackTint      | Black tint (used for black)     | Color                      | 1            |
| alphaThreshold | Alpha value considered pickable | float (uom-qualified)      | 1            |

The actual image content is defined by a Resource, which can be specified by one or multiple properties:

**Table 24 – Resource class**

| NAME   | DEFINITION                                | TYPE   | MULTIPLICITY |
|--------|---|--------|--------------|
| url    | URL for online resource                   | string | 0..1         |
| path   | (preferably relative) path to local file  | string | 0..1         |
| id     | ID within a database table or a sprite    | string | 0..1         |
| type   | Selected media type for the resource      | string | 0..1         |
| ext    | File extension to build paths/URL with id | string | 0..1         |
| sprite | Name of source sprite file                | string | 0..1         |

### 8.1.6.3. Text Graphics



**Figure 15 – Text Class UML Diagram**

A Text is one type of Graphic defined by this requirements class that can be used as part of a Marker.

**Table 25 – Text**

| NAME      | DEFINITION                        | DATA TYPE AND VALUE | MULTIPLICITY |
|-----------|-----------------------------------|---------------------|--------------|
| text      | The character string for the text | string (unicode)*   | 1            |
| font      | The font to use for the text      | Font                | 0..1         |
| alignment | The alignment to use for the text | TextAlignment       | 0..1         |

This requirements class requires support for identifier parameter value expression for the text property without any additional requirements class. This allows to display the value of feature properties with a Text Marker.

**Table 26 – TextAlignment**

| NAME          | DEFINITION           | DATA TYPE AND VALUE | MULTIPLICITY |
|---------------|----------------------|---------------------|--------------|
| horzAlignment | Horizontal alignment | HAlignment          | 0..1         |
| vertAlignment | Vertical alignment   | VAlignment          | 0..1         |

**Table 27 – HAlignment enumeration**

| NAME   | DEFINITION       |
|--------|------------------|
| left   | Left alignment   |
| center | Center alignment |
| right  | Right alignment  |

**Table 28 – VAlignment enumeration**

| NAME   | DEFINITION       |
|--------|------------------|
| top    | Top alignment    |
| middle | Middle alignment |

| NAME   | DEFINITION       |
|--------|------------------|
| bottom | Bottom alignment |

The font property of a Text Graphic is defined uses the following *Font* class:

**Table 29 – Font class**

| NAME   | DEFINITION            | DATA TYPE AND VALUE | MULTIPLICITY |
|--------|-----------------------|---------------------|--------------|
| face   | Face name             | string              | 0..1         |
| size   | Size of the font (pt) | float               | 0..1         |
| bold   | Use bold style        | bool                | 0..1         |
| italic | Use italic style      | bool                | 0..1         |

## 8.2. Requirements

---

### 8.2.1. Basic Vector Features Styling

| REQUIREMENTS CLASS 2: BASIC VECTOR FEATURES STYLING |   |
|---|---|
| IDENTIFIER  | <a href="http://www.opengis.net/spec/symbology-1/2.0/req/vector">http://www.opengis.net/spec/symbology-1/2.0/req/vector</a>                   |
| TARGET TYPE   | Style encodings and Renderers   |
| PREREQUISITE  | Requirements class 1: <a href="http://www.opengis.net/spec/symbology-1/2.0/req/core">http://www.opengis.net/spec/symbology-1/2.0/req/core</a> |

#### 8.2.1.1. Symbolizer **fill** property

| REQUIREMENT 20              |
|-----------------------------|
| IDENTIFIER /req/vector/fill |

## REQUIREMENT 20

- A An Encoding SHALL support defining a **fill** Symbolizer property as an object including a **color** and an **opacity**.
- B A Renderer SHALL support filling vector geometry based on a **fill** property specifying a **color** and an **opacity**.

### 8.2.1.2. Symbolizer **stroke** property

## REQUIREMENT 21

**IDENTIFIER** /req/vector/stroke

- A An Encoding SHALL support defining a **stroke** Symbolizer property as an object including a **color** and a units of measure-qualified ("uom-qualified") **width**.
- B A Renderer SHALL support drawing the stroke of vector geometry based on a **stroke** property specifying a **color** and a uom-qualified **width**.

### 8.2.1.3. Graphical Units of Measure

## REQUIREMENT 22

**IDENTIFIER** /req/vector/units

- A An Encoding SHALL support qualifying distance properties identified as "uom-qualified" with a unit of measure (pixel, millimeter, inch, percentage, meter, foot).
- B A Renderer SHALL support applying the appropriate unit transformation when rendering elements specifying a uom-qualified distances.

### 8.2.1.4. Symbolizer **marker** property

## REQUIREMENT 23

**IDENTIFIER** /req/vector/marker

- A An Encoding SHALL support defining a **marker** Symbolizer property as an array of graphical elements (Graphics).

## REQUIREMENT 23

- B A Renderer SHALL support drawing the graphical elements of a marker at the points of vector geometry (for points and line strings) and at the centroid of polygons.

### 8.2.1.5. Graphics

## REQUIREMENT 24

**IDENTIFIER** /req/vector/graphics

- A An Encoding SHALL support defining graphical elements (graphics) specifying a uom-qualified 2D real position offsetting the graphic from its original position.
- B A Renderer SHALL support drawing the Graphics at the specified uom-qualified 2D position offset relative to its original position.

### 8.2.1.6. Dot Graphics

## REQUIREMENT 25

**IDENTIFIER** /req/vector/dot

- A An Encoding SHALL support defining a Dot Graphic inheriting from a base Shape class specifying a stroke, from which the color and the size of the point is inferred.
- B A Renderer SHALL support drawing the Graphics as a round dot using the width of its Stroke as the point size and in the color of the Stroke.

### 8.2.1.7. Image Graphics

## REQUIREMENT 26

**IDENTIFIER** /req/vector/image

- A An Encoding SHALL support defining an Image Graphic inheriting from a base Shape class specifying a stroke, from which the color and the size of the point is inferred.
- B A Renderer SHALL support drawing the Graphics as a round dot using the width of its Stroke as the point size and in the color of the Stroke.

### 8.2.1.8. Text Graphics

#### REQUIREMENT 27

IDENTIFIER /req/vector/text

- A An Encoding SHALL support defining a Text Graphic with a text unicode string content, a font, and an alignment with a horizontal (horzAlignment: left, right or center) and vertical component (vertAlignment: top, middle, bottom).
- B A Renderer SHALL support draw the text of a Text Graphic using the font and the alignment specified.

### 8.2.1.9. Fonts

#### REQUIREMENT 28

IDENTIFIER /req/vector/fonts

- A An Encoding SHALL support defining Fonts with a face property indicating the face name (also known as the font *family*), a size specified in *points*, a bold flag indicating to use a bold weight if true, and an italic flag indicating to use an italic style if true.
- B A Renderer SHALL support drawing text using the fonts specified.

9

# REQUIREMENTS CLASSES FOR COVERAGE STYLING

---

# REQUIREMENTS CLASSES FOR COVERAGE STYLING

---

## 9.1. Requirements Class “Basic Coverage Styling”

---

### 9.1.1. Overview

This requirements class adds support for defining how to portray coverage data by mapping values from the range (e.g., individual imagery bands) to color channels or to a single channel, as well as providing an option to apply a color and/or opacity map based on the values.

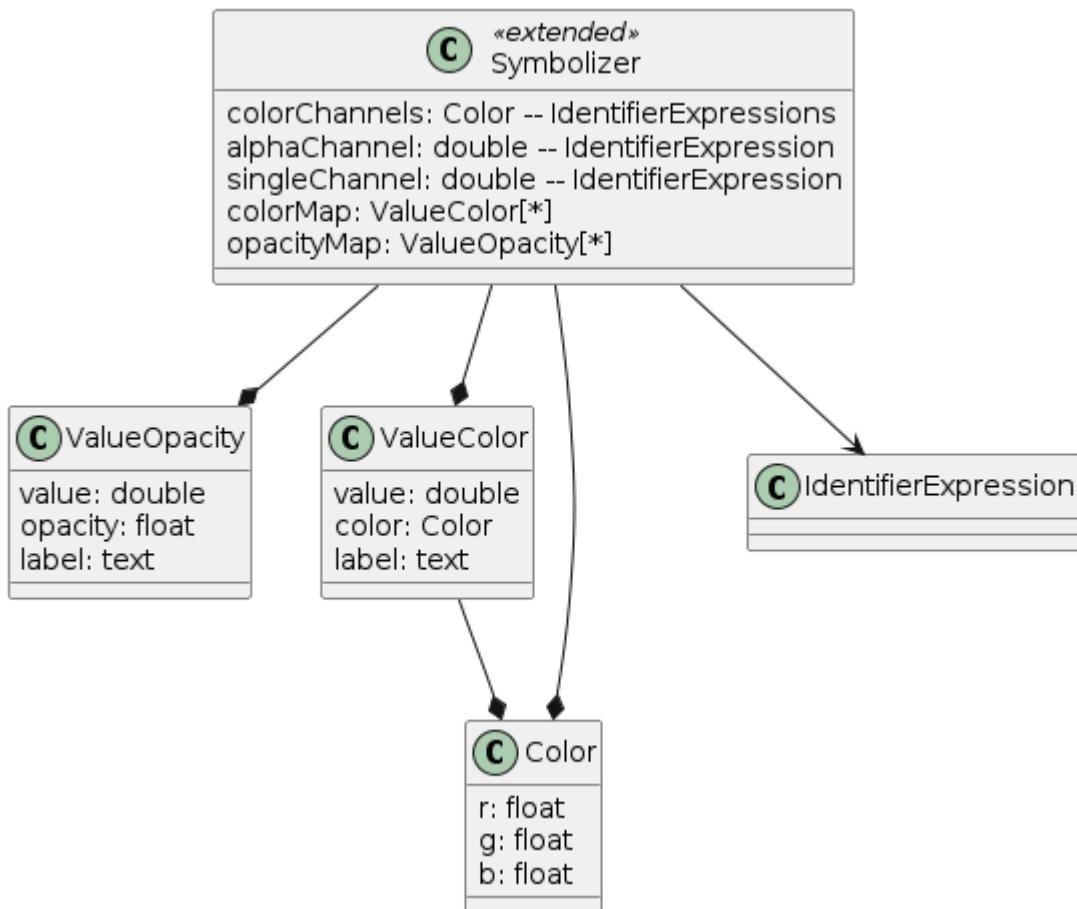


Figure 16 – Extended Symbolizer Class UML Diagram

### 9.1.1.1. Extended Identifiers

This requirements class defines as valid identifiers all of the accessible properties (the values of its range, as defined by the range type) for a coverage being portrayed with the name of those properties being the text of the identifier. Those identifiers are to be resolved with the value of that property. An encoding must support an escaping mechanism in cases where the name of a feature property might clash with a syntactic element.

### 9.1.1.2. Extended Symbolizer

**Table 30 – Extended Symbolizer properties**

| NAME          | DEFINITION  | DATA TYPE AND VALUE | MULTIPLICITY |
|---------------|---|---------------------|--------------|
| colorChannels | Value of the Red, Green and Blue color channels   | Color               | 0..1         |
| alphaChannel  | Value of the alpha (opacity) channel              | float               | 0..1         |
| singleChannel | Value of a single (gray-scale) output channel     | float               | 0..1         |
| colorMap      | Color map to be applied based on single Channel   | ValueColor          | 0..*         |
| opacityMap    | Opacity map to be applied based on single Channel | ValueOpacity        | 0..*         |

This requirements class requires support for identifier parameter value expression for the red (r), green (g) and blue (b) components of the colorChannels, alphaChannel and singleChannel properties without any additional requirements class.

This allows to map the range values of a coverage to the output color channels.

The color map is defined with a Value/Color pair object:

**Table 31 – ValueColor properties**

| NAME  | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|-------|--|---------------------|--------------|
| value | Key value for selecting this color                   | float               | 1            |
| color | Color associated with this value                     | Color               | 1            |
| name  | Label to use for this value when generating a legend | string              | 0..1         |

Similarly, the opacity map is defined with a Value/Opacity pair object:

**Table 32 – ValueOpacity properties**

| NAME  | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|-------|--|---------------------|--------------|
| value | Key value for selecting this color                   | float               | 1            |
| color | Color associated with this value                     | Color               | 1            |
| name  | Label to use for this value when generating a legend | string              | 0..1         |

### 9.1.1.3. Colors

Both the `colorChannels` and the `colorMap` properties use a `Color` class, specified using red, green and blue components. The ability to define Colors in other spaces (e.g., Lab, CMYK) is defined in separate requirements classes and applies wherever this basic RGB Color class is used.

**Table 33 – Color**

| NAME | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|------|------------|---------------------|--------------|
| r    | Red        | float               | 1            |
| g    | Green      | float               | 1            |
| b    | Blue       | float               | 1            |

## 9.1.2. Requirements

### REQUIREMENTS CLASS 3: BASIC COVERAGE STYLING

**IDENTIFIER** <http://www.opengis.net/spec/symbology-1/2.0/req/coverage>

**TARGET TYPE** Style encodings and Renderers

**PREREQUISITE** Requirements class 1: <http://www.opengis.net/spec/symbology-1/2.0/req/core>

### 9.1.2.1. Symbolizer `colorChannels` property

#### REQUIREMENT 29

IDENTIFIER /req/coverage/color-channels

- A An Encoding SHALL support defining a `colorChannels` Symbolizer property as a Color object.
- B A Renderer SHALL support ...

### 9.1.2.2. Symbolizer `alphaChannel` property

#### REQUIREMENT 30

IDENTIFIER /req/coverage/alpha-channel

- A An Encoding SHALL support defining a `alphaChannel` Symbolizer property as a float.
- B A Renderer SHALL support ...

### 9.1.2.3. Symbolizer `singleChannel` property

#### REQUIREMENT 31

IDENTIFIER /req/coverage/single-channel

- A An Encoding SHALL support defining a `singleChannel` Symbolizer property as a float.
- B A Renderer SHALL support ...

### 9.1.2.4. Symbolizer `colorMap` property

## REQUIREMENT 32

**IDENTIFIER** /req/coverage/color-map

- A An Encoding SHALL support defining a colorMap Symbolizer property as an array of value (float) and color (Color) pairs which can be tagged with a name.
- B A Renderer SHALL support ...

### 9.1.2.5. Symbolizer opacityMap property

## REQUIREMENT 33

**IDENTIFIER** /req/coverage/opacity-map

- A An Encoding SHALL support defining a opacityMap Symbolizer property as an array of value (float) and opacity (float) pairs which can be tagged with a name.
- B A Renderer SHALL support ...

## 9.2. Requirements Class “Hill Shading”

### 9.2.1. Overview

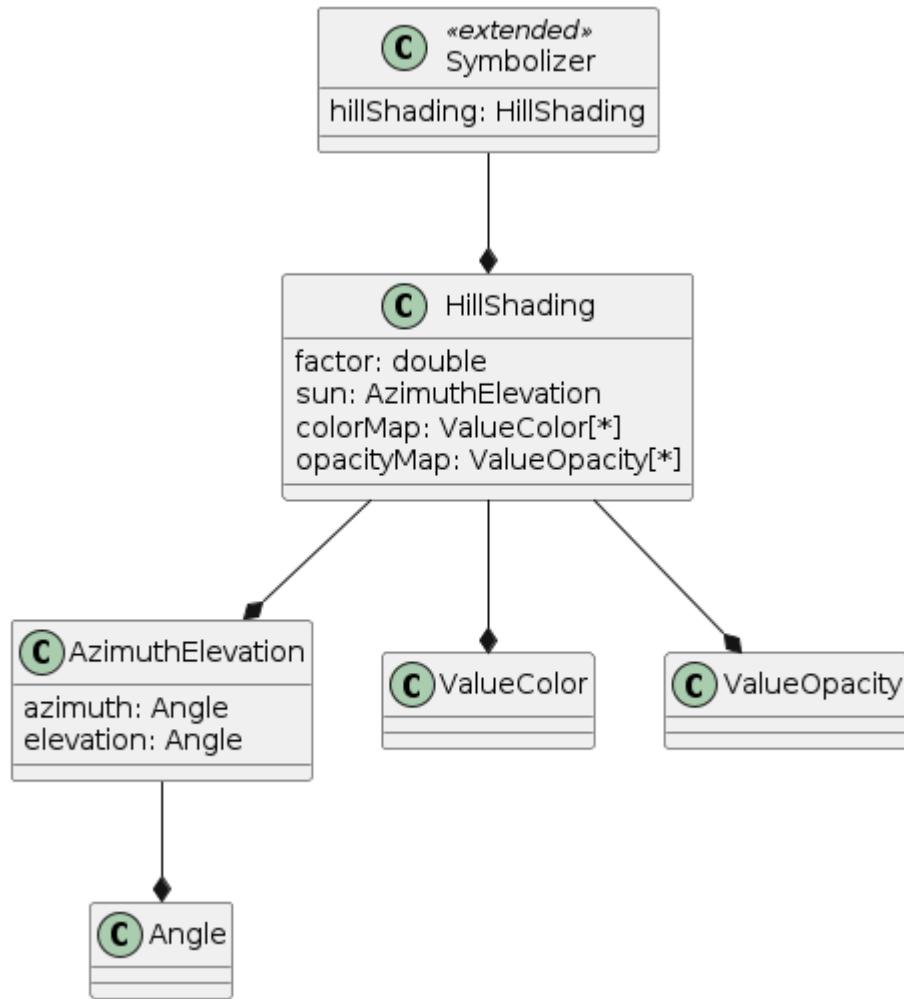


Figure 17 – Extended Symbolizer Class UML Diagram

This requirements class adds the capability to portray elevation coverages with a hill shading style. It depends on the *Basic Coverage Styling* requirements class.

#### 9.2.1.1. Extended Symbolizer

**Table 34 – Extended Symbolizer properties**

| NAME        | DEFINITION              | DATA TYPE AND VALUE | MULTIPLICITY |
|-------------|-------------------------|---------------------|--------------|
| hillShading | Hill shading parameters | HillShading         | 0..1         |

**Table 35 – HillShading properties**

| NAME       | DEFINITION  | DATA TYPE AND VALUE | MULTIPLICITY |
|------------|---|---------------------|--------------|
| factor     | Factor controlling the intensity of the shading     | float               | 0..1         |
| sun        | Orientation of the sun                              | AzimuthElevation    | 0..1         |
| colorMap   | Color map to be applied based on calculated shade   | ValueColor          | 0..*         |
| opacityMap | Opacity map to be applied based on calculated shade | ValueOpacity        | 0..*         |

The sun property is specified using this AzimuthElevation class:

**Table 36 – AzimuthElevation properties**

| NAME      | DEFINITION                             | DATA TYPE AND VALUE | MULTIPLICITY |
|-----------|--|---------------------|--------------|
| azimuth   | Azimuth angle relative to North        | Angle               | 0..1         |
| elevation | Elevation angle relative to the ground | Angle               | 0..1         |

## 9.2.2. Requirements

### REQUIREMENTS CLASS 4: HILL SHADING

|              |   |
|--------------|---|
| IDENTIFIER   | <a href="http://www.opengis.net/spec/symbology-1/2.0/req/hillshading">http://www.opengis.net/spec/symbology-1/2.0/req/hillshading</a>                 |
| TARGET TYPE  | Style encodings and Renderers   |
| PREREQUISITE | Requirements class 3: <a href="http://www.opengis.net/spec/symbology-1/2.0/req/coverage">http://www.opengis.net/spec/symbology-1/2.0/req/coverage</a> |

### 9.2.2.1. Symbolizer hillShading property

#### REQUIREMENT 34

IDENTIFIER /req/hillshading/hillshading

- A An Encoding SHALL support defining a hillshading Symbolizer property as an object including factor, sun, colorMap and opacityMap properties.
- B A Renderer SHALL support ...

### 9.2.2.2. HillShading factor property

#### REQUIREMENT 35

IDENTIFIER /req/hillshading/factor

- A An Encoding SHALL support defining a factor HillShading property as a float.
- B A Renderer SHALL support ...

### 9.2.2.3. HillShading sun property

#### REQUIREMENT 36

IDENTIFIER /req/hillshading/sun

- A An Encoding SHALL support defining a sun HillShading property as an object consisting of azimuth and elevation angle members representing the orientation of the sun relative to the terrain.
- B A Renderer SHALL support ...

### 9.2.2.4. HillShading colorMap property

## REQUIREMENT 37

**IDENTIFIER** /req/hillshading/color-map

- A An Encoding SHALL support defining a colorMap HillShading property as an array of value (float) and color (Color) pairs.
- B A Renderer SHALL support ...

### 9.2.2.5. HillShading opacityMap property

## REQUIREMENT 38

**IDENTIFIER** /req/hillshading/opacity-map

- A An Encoding SHALL support defining a opacityMap HillShading property as an array of value (float) and opacity (float) pairs.
- B A Renderer SHALL support ...

10

# REQUIREMENTS CLASSES FOR LABELING

---

## 10.1. Requirements Class “Basic Labeling”

### 10.1.1. Overview



**Figure 18** – Label Class UML Diagram

This requirements class adds support for labels that are placed using a placement algorithm (and may not always be placed) drawn as a separate pass on top of styled vector features and coverages. Like Markers, Labels inherit from the MultiGraphic class and may contain multiple graphical elements.

**Table 37** – Extended Symbolizer Class

| NAME  | DEFINITION                | TYPE  | MULTIPLICITY |
|-------|---------------------------|-------|--------------|
| label | Graphic placed and drawns | Label | 0..1         |

## 10.1.2. Requirements

# 10.2. Requirements Class “Font Outlines”

---

### 10.2.1. Overview



Figure 19 – Font outlines UML Diagram

This requirements class adds support for Text font outlines to improve readability on any background.

#### 10.2.1.1. Font Outlines

Table 38 – Extended Text Class

| NAME    | DEFINITION           | TYPE        | MULTIPLICITY |
|---------|----------------------|-------------|--------------|
| outline | Outline for the text | FontOutline | 0..1         |

**Table 39** – FontOutline class

| NAME    | DEFINITION             | DATA TYPE AND VALUE | MULTIPLICITY |
|---------|------------------------|---------------------|--------------|
| size    | Size of the outline    | float               | 0..1         |
| opacity | Opacity of the outline | float               | 0..1         |
| color   | Color of the outline   | Color               | 0..1         |

## 10.2.2. Requirements

11

# REQUIREMENTS CLASSES FOR SHAPES

---

## 11.1. Requirements Class “Shape Graphics”

### 11.1.1. Overview

This requirements class adds support for vector shape graphics.

#### 11.1.1.1. Rectangles, Circles, and Ellipses

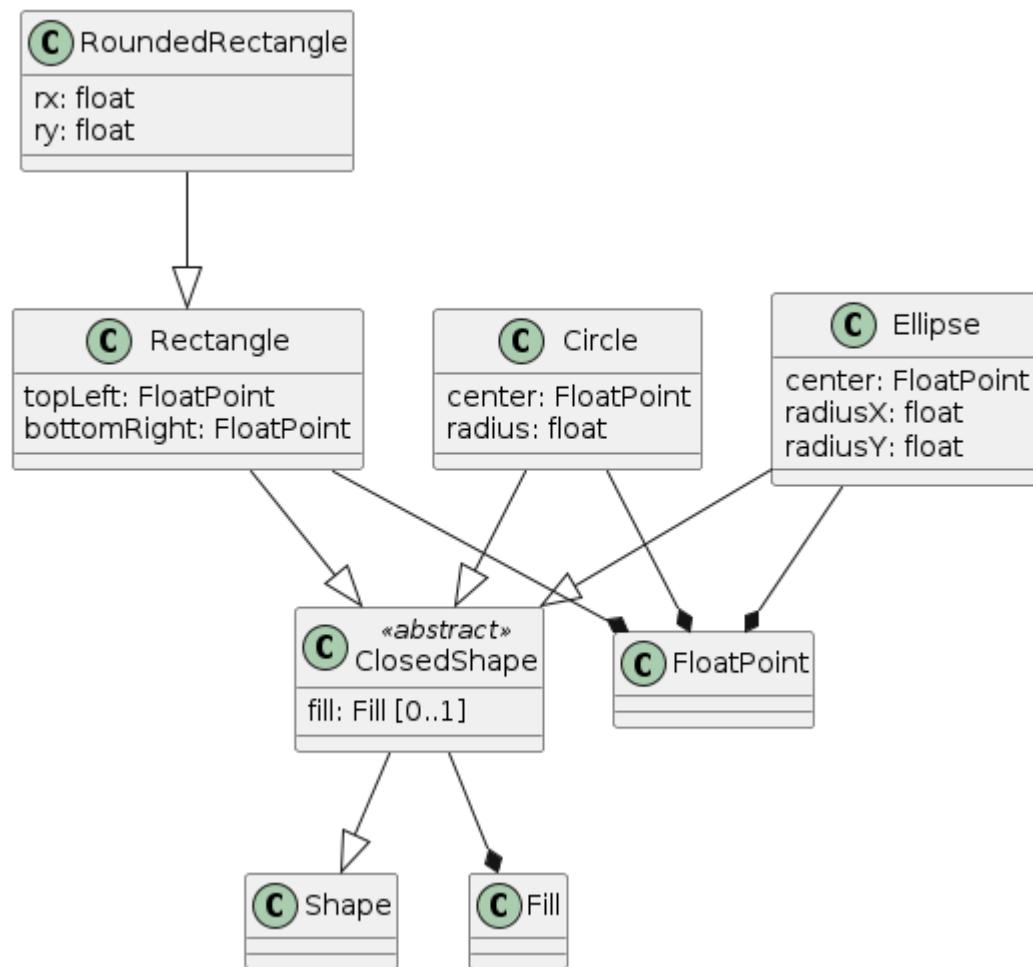


Figure 20 – Rectangles, Circles and Ellipses Classes UML Diagram

**Table 40** – Class ClosedShape

| NAME | DEFINITION        | DATA TYPE AND VALUE | MULTIPLICITY |
|------|-------------------|---------------------|--------------|
| fill | Fill of the shape | Fill                | 1            |

#### 11.1.1.1.1. Rectangles

**Table 41** – Rectangle

| NAME        | DEFINITION                           | DATA TYPE AND VALUE | MULTIPLICITY |
|-------------|--------------------------------------|---------------------|--------------|
| topLeft     | Top left corner of the rectangle     | FloatPoint          | 1            |
| bottomRight | Bottom right corner of the rectangle | FloatPoint          | 1            |

#### 11.1.1.1.2. Rounded Rectangles

**Table 42** – Class RoundRectangle

| NAME | DEFINITION                               | DATA TYPE AND VALUE | MULTIPLICITY |
|------|--|---------------------|--------------|
| rx   | Horizontal radius of the rounded corners | float               | 1            |
| ry   | Vertical radius of the rounded corners   | float               | 1            |

#### 11.1.1.1.3. Circles

**Table 43** – Class Circle

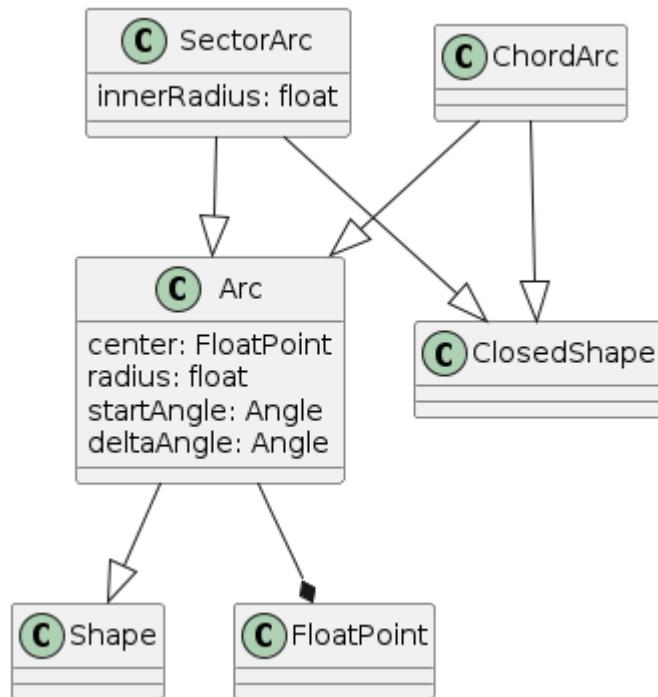
| NAME   | DEFINITION           | DATA TYPE AND VALUE | MULTIPLICITY |
|--------|----------------------|---------------------|--------------|
| center | Center of the circle | FloatPoint          | 1            |
| radius | Radius of the circle | float               | 1            |

#### 11.1.1.1.4. Ellipses

**Table 44 – Class Ellipse**

| NAME    | DEFINITION            | DATA TYPE AND VALUE | MULTIPLICITY |
|---------|-----------------------|---------------------|--------------|
| center  | Center of the ellipse | FloatPoint          | 1            |
| radiusX | Horizontal radius     | float               | 1            |
| radiusY | Vertical radius       | float               | 1            |

#### 11.1.1.2. Arcs



**Figure 21 – Arc Classes UML Diagram**

**Table 45 – Arc class**

| NAME   | DEFINITION | TYPE       | MULTIPLICITY |
|--------|------------|------------|--------------|
| center | Center     | FloatPoint | 1            |

| NAME       | DEFINITION  | TYPE  | MULTIPLICITY |
|------------|-------------|-------|--------------|
| radius     | Radius      | float | 1            |
| startAngle | Start angle | Angle | 1            |
| deltaAngle | Delta angle | Angle | 1            |

**Table 46** – SectorArc class

| NAME        | DEFINITION   | TYPE  | MULTIPLICITY |
|-------------|--------------|-------|--------------|
| innerRadius | Inner radius | float | 1            |

**Table 47** – ChordArc class

| NAME                    | DEFINITION | TYPE | MULTIPLICITY |
|-------------------------|------------|------|--------------|
| (no additional members) |            |      |              |

### 11.1.1.3. Paths

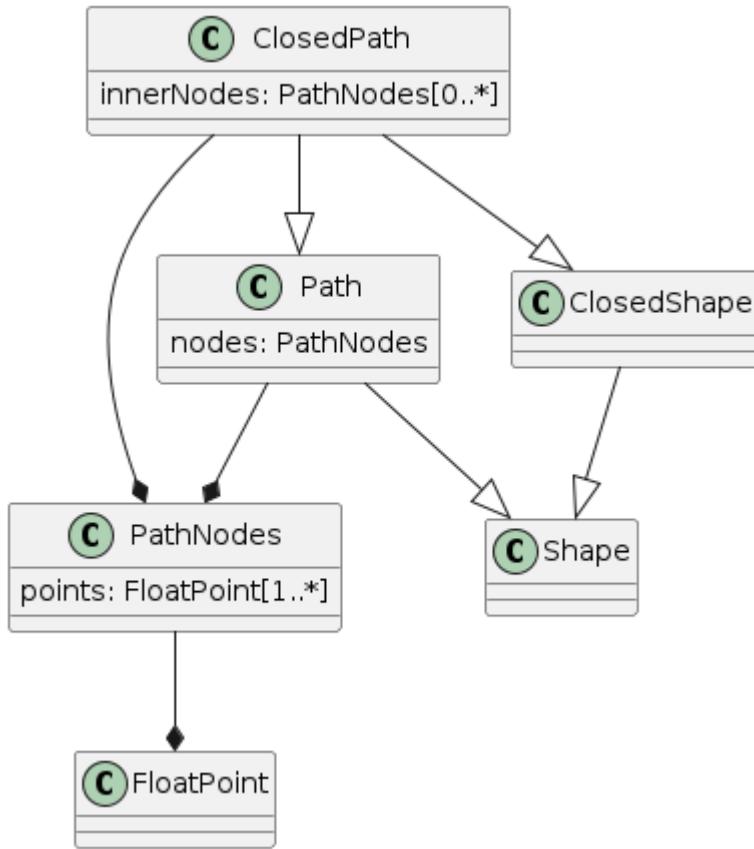


Figure 22 – Path Classe UML Diagram

Table 48 – Path class

| NAME  | DEFINITION        | TYPE      | MULTIPLICITY |
|-------|-------------------|-----------|--------------|
| nodes | Nodes of the path | PathNodes | 1            |

#### 11.1.1.3.1. Closed Paths

A closed path is a **ClosedShape** that can be filled, and can optionally contain inner nodes to create holes, like polygon interior rings.

**Table 49** – ClosedPath class

| NAME       | DEFINITION              | TYPE      | MULTIPLICITY |
|------------|-------------------------|-----------|--------------|
| innerNodes | Inner nodes of the path | PathNodes | 0..*         |

### 11.1.2. Requirements

## 11.2. Requirements Class “Shapes Outlines”

---

### 11.2.1. Overview

**Table 50** – ShapeOutline class

| NAME      | DEFINITION               | TYPE  | MULTIPLICITY |
|-----------|--------------------------|-------|--------------|
| color     | Color of the outline     | Color | 0..1         |
| opacity   | Opacity of the outline   | float | 0..1         |
| thickness | Thickness of the outline | float | 0..1         |

**Table 51** – Extended Shape class

| NAME    | DEFINITION    | TYPE         | MULTIPLICITY |
|---------|---------------|--------------|--------------|
| outline | Shape outline | ShapeOutline | 0..1         |

### 11.2.2. Requirements

12

# REQUIREMENTS CLASS “MULTI GRAPHICS AND TRANSFORMS”

---

# REQUIREMENTS CLASS “MULTI GRAPHICS AND TRANSFORMS”

## 12.1. Overview

This requirements class adds support for vector graphic hierarchies and transformations.

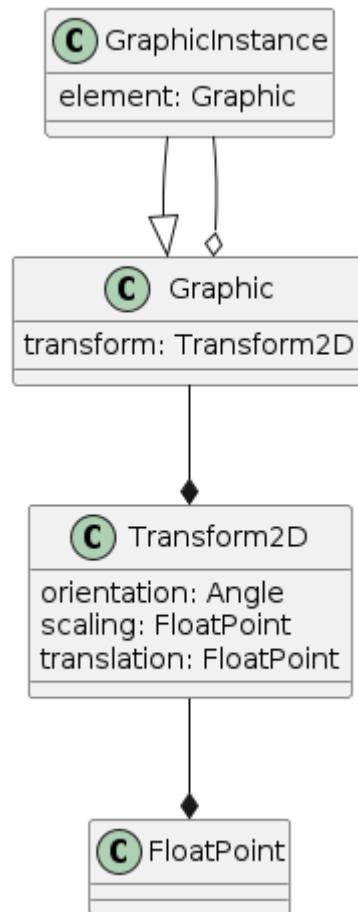


Figure 23 – MultiGraphic and Transforms UML Diagram

### 12.1.1. Graphic and MultiGraphic Extensions

This requirements class removes the restriction on MultiGraphics containing other MultiGraphics.

**Table 52 – Extended Graphic class**

| NAME      | DEFINITION        | TYPE        | MULTIPLICITY |
|-----------|-------------------|-------------|--------------|
| transform | 2D transformation | Transform2D | 1            |

The `transform.translation` is equivalent to the `Graphic's position` property.

**Table 53 – Transform2D class**

| NAME        | DEFINITION  | TYPE       | MULTIPLICITY |
|-------------|-------------|------------|--------------|
| orientation | Orientation | Angle      | 1            |
| scaling     | Scaling     | FloatPoint | 1            |
| translation | Translation | FloatPoint | 1            |

## 12.1.2. Graphic Instances

The `GraphicInstance` class allows instantiating multiple instances of a single `Graphic` definition object, with each instance having a different transformation applied.

**Table 54 – GraphicInstance class**

| NAME    | DEFINITION           | TYPE    | MULTIPLICITY |
|---------|----------------------|---------|--------------|
| element | Instantiated graphic | Graphic | 1            |

## 12.2. Requirements

---

13

# REQUIREMENTS CLASSES FOR ADVANCED STROKES

---

# REQUIREMENTS CLASSES FOR ADVANCED STROKES

## 13.1. Requirements Class “Joins and Caps”

### 13.1.1. Overview



**Figure 24 – Joins and Caps classes UML diagram**

This requirements class adds support for Strokes rendered with additional join and cap types.

**Table 55 – Extended Stroke class**

| NAME | DEFINITION | TYPE       | MULTIPLICITY |
|------|------------|------------|--------------|
| join | Join       | StrokeJoin | 0..1         |
| cap  | Cap        | StrokeCap  | 0..1         |

**Table 56 – StrokeJoin enumeration**

| NAME  | DEFINITION |
|-------|------------|
| miter | Miter join |
| round | Round join |
| bevel | Bevel join |

**Table 57 – StrokeCap enumeration**

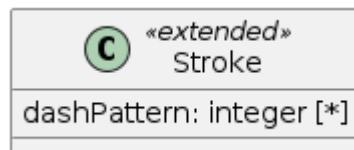
| NAME   | DEFINITION |
|--------|------------|
| butt   | Butt cap   |
| round  | Round cap  |
| square | Square cap |

### 13.1.2. Requirements

## 13.2. Requirements Class “Dashes”

---

### 13.2.1. Overview



**Figure 25 – Dashed strokes class UML diagram**

This requirements class adds support for dashed Strokes.

**Table 58 – Extended Stroke class**

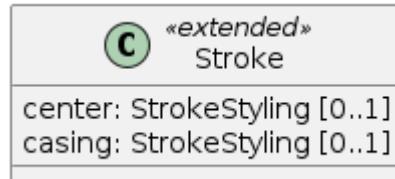
| NAME        | DEFINITION   | TYPE | MULTIPLICITY |
|-------------|--------------|------|--------------|
| dashPattern | Dash pattern | int  | 0..*         |

### 13.2.2. Requirements

## 13.3. Requirements Class “Casing and Centerline”

---

### 13.3.1. Overview



**Figure 26 – Casing and centerline strokes class UML diagram**

This requirements class adds support for Strokes with a casing and centerline.

**Table 59 – Extended Stroke class**

| NAME   | DEFINITION                  | TYPE          | MULTIPLICITY |
|--------|-----------------------------|---------------|--------------|
| casing | Style of stroke casing      | StrokeStyling | 0..1         |
| center | Style of stroke center line | StrokeStyling | 0..1         |

### 13.3.2. Requirements

## 13.4. Requirements Class “Pattern Strokes”

---

### 13.4.1. Overview



**Figure 27** – Pattern strokes class UML Diagram

This requirements class adds support for Strokes with a pattern defined by a Graphic.

**Table 60** – Extended Stroke class

| NAME    | DEFINITION      | TYPE    | MULTIPLICITY |
|---------|-----------------|---------|--------------|
| pattern | Pattern graphic | Graphic | 0..1         |

### 13.4.2. Requirements

14

# REQUIREMENTS CLASSES FOR ADVANCED FILLS

---

# REQUIREMENTS CLASSES FOR ADVANCED FILLS

## 14.1. Requirements Class “Pattern Fills”

### 14.1.1. Overview

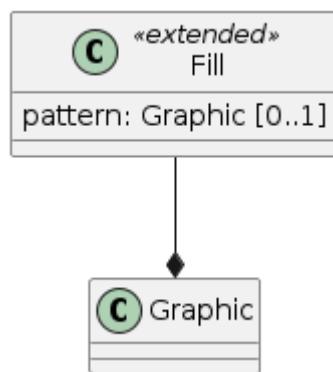


Figure 28 – Pattern Fill UML Diagram

This requirements class adds support for defining how to fill a shape with a pattern.

Table 61 – Extended Fill class

| NAME    | DEFINITION                   | TYPE    | MULTIPLICITY |
|---------|------------------------------|---------|--------------|
| pattern | Graphic to repeat in pattern | Graphic | 0..1         |

### 14.1.2. Requirements

## 14.2. Requirements Class “Hatches and Gradients, Stipples”

---

### 14.2.1. Overview



Figure 29 – Hatches, Gradients and Stipple Fills UML Diagram

This requirements class adds support for hatch, stipple and gradient fills.

Table 62 – Extended Fill class

| NAME       | DEFINITION | TYPE       | MULTIPLICITY |
|------------|------------|------------|--------------|
| hatchStyle | Hatch styl | HatchStyle | 0..1         |

| NAME         | DEFINITION | TYPE         | MULTIPLICITY |
|--------------|------------|--------------|--------------|
| stippleStyle | Opacity    | StippleStyle | 0..1         |
| gradient     | Percent    | ColorKey     | 0..*         |

#### 14.2.1.1. Gradients

Table 63 – ColorKey class

| NAME    | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|---------|------------|---------------------|--------------|
| color   | Color      | Color               | 1            |
| opacity | Opacity    | float               | 0..1         |
| percent | Percent    | float               | 0..1         |

#### 14.2.1.2. Stipples

Table 64 – StippleStyle class

| NAME   | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|--------|------------|---------------------|--------------|
| light  | Light      | float               | 1            |
| medium | Medium     | float               | 1            |
| heavy  | Heavy      | float               | 1            |

#### 14.2.1.3. Hatches

Table 65 – HatchStyle class

| NAME    | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|---------|------------|---------------------|--------------|
| forward | Forward    | float               | 1            |

| NAME     | DEFINITION | DATA TYPE AND VALUE | MULTIPLICITY |
|----------|------------|---------------------|--------------|
| backward | Backward   | float               | 1            |
| xCross   | X-Cross    | float               | 1            |
| cross    | Cross      | float               | 1            |

## 14.2.2. Requirements

15

# REQUIREMENTS CLASS “SYMBOLIZER PARAMETER VALUE EXPRESSIONS”

---

# REQUIREMENTS CLASS “SYMBOLIZER PARAMETER VALUE EXPRESSIONS”

---

## 15.1. Overview

---

This requirements class adds support for using **ParameterValues** i.e., arbitrary **Expressions** (not only literals), for all **Symbolizer** properties.

## 15.2. Requirements

---

16

# REQUIREMENTS CLASSES FOR ADDITIONAL EXPRESSIONS

---

# REQUIREMENTS CLASSES FOR ADDITIONAL EXPRESSIONS

## 16.1. Requirements Class “Any right-hand operands”

### 16.1.1. Overview

This requirements class removes the restriction that right-hand side operands of RelationExpressions are limited to LiteralExpressions. For expressions encoded using CQL2, it is analogous to the *CQL2 Property-Property comparison* requirements class.

### 16.1.2. Requirements

## 16.2. Requirements Class “Conditional Expressions”

### 16.2.1. Overview

#### 16.2.1.1. Conditional expressions



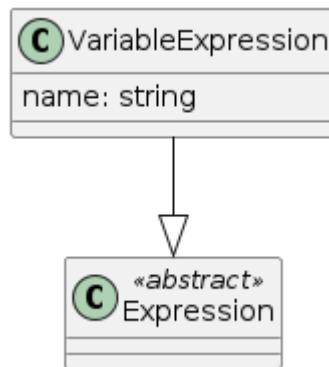
Figure 30 – Conditional Expressions UML Class Diagram

**Table 66** – ConditionalExpression class

| NAME      | DEFINITION                                      | TYPE       | MULTIPLICITY |
|-----------|---|------------|--------------|
| condition | Condition                                       | Expression | 1            |
| thenExp   | Expression resolving to when condition is true  | Expression | 1            |
| elseExp   | Expression resolving to when condition is false | Expression | 1            |

## 16.3. Requirements Class “Variables”

### 16.3.1. Overview



**Figure 31** – Variable Expressions UML Class Diagram

This requirements class adds support for defining variables that can be used to facilitate re-use of definitions in encodings, as well as to provide configurable elements that can be associated with application control such as a slider or drop-down control.

#### 16.3.1.1. Variable expressions

**Table 67** – VariableExpression class

| NAME | DEFINITION           | TYPE   | MULTIPLICITY |
|------|----------------------|--------|--------------|
| name | Name of the variable | string | 1            |

### **16.3.2. Requirements**

17

# REQUIREMENTS CLASSES FOR ADDITIONAL OPERATORS

---

# REQUIREMENTS CLASSES FOR ADDITIONAL OPERATORS

---

## 17.1. Requirements Class “Arithmetic Operators”

---

### 17.1.1. Overview

This requirements class adds support for arithmetic operations.



**Figure 32 – Arithmetic Operators UML Diagram**

**Table 68 – arithmetic**

| NAME | DEFINITION     | DATA TYPE AND VALUE | MULTIPLICITY |
|------|----------------|---------------------|--------------|
| add  | Addition       | Numeric             | 1..1         |
| sub  | Subtraction    | Numeric             | 1..1         |
| mul  | Multiplication | Numeric             | 1..1         |
| div  | Division       | Numeric             | 1..1         |

| NAME   | DEFINITION       | DATA TYPE AND VALUE | MULTIPLICITY |
|--------|------------------|---------------------|--------------|
| intDiv | Integer Division | Numeric             | 1..1         |
| mod    | Modulus          | Numeric             | 1..1         |
| pow    | Power            | Numeric             | 1..1         |

## 17.1.2. Requirements

# 17.2. Requirements Class “Bitwise Operators”

---

## 17.2.1. Overview

This requirements class adds support for operations on individual bits.

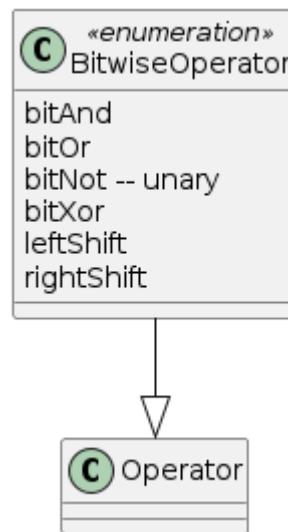


Figure 33 – Bitwise Operators UML Diagram

Table 69 – bitwise

| NAME   | DEFINITION  | DATA TYPE AND VALUE | MULTIPLICITY |
|--------|-------------|---------------------|--------------|
| bitAnd | Bitwise AND | Integer             | 1..1         |

| NAME       | DEFINITION  | DATA TYPE AND VALUE | MULTIPLICITY |
|------------|-------------|---------------------|--------------|
| bitOr      | Bitwise OR  | Integer             | 1..1         |
| bitNot     | Bitwise NOT | Integer             | 1..1         |
| bitXor     | Bitwise XOR | Integer             | 1..1         |
| leftShift  | Left Shift  | Integer             | 1..1         |
| rightShift | Right Shift | Integer             | 1..1         |

## 17.2.2. Requirements

## 17.3. Requirements Class “Text Relation Operators”

---

### 17.3.1. Overview

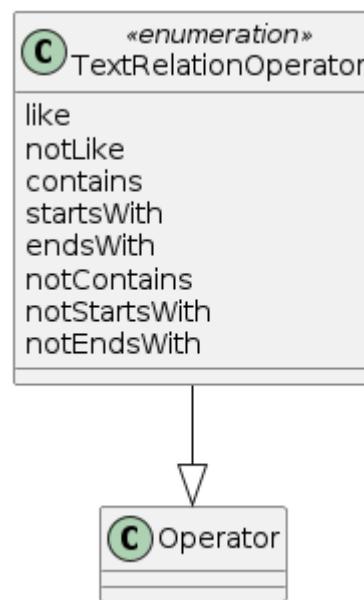


Figure 34 – Bitwise Operators UML Diagram

This requirements class adds more advanced support for evaluating the relation between text values, including the *like* operator, *starts with*, *contains*, *ends with*, as well as *not* variants for all these.

**Table 70** – comparison

| NAME          | DEFINITION          | DATA TYPE AND VALUE | MULTIPLICITY |
|---------------|---------------------|---------------------|--------------|
| like          | Like                | Text                | 1..1         |
| notLike       | Not Like            | Text                | 1..1         |
| contains      | Contains            | Text                | 1..1         |
| startsWith    | Starts With         | Text                | 1..1         |
| endsWith      | Ends With           | Text                | 1..1         |
| notContains   | Does Not Contain    | Text                | 1..1         |
| notStartsWith | Does Not Start With | Text                | 1..1         |
| notEndsWith   | Does Not End With   | Text                | 1..1         |

### 17.3.2. Requirements

18

# REQUIREMENTS CLASSES FOR FUNCTIONS

---

## 18.1. Requirements Class “Function Expressions”

### 18.1.1. Overview

This requirements class adds support for function call expressions.

#### 18.1.1.1. Function call expressions

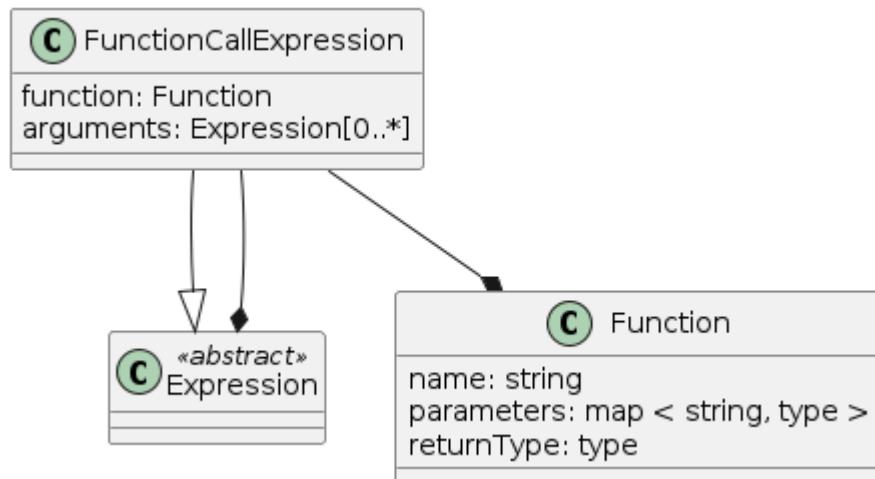


Figure 35 – Functions UML Class Diagram

Table 71 – FunctionCallExpression class

| NAME      | TYPE       | DEFINITION                | MULTIPLICITY |
|-----------|------------|---------------------------|--------------|
| function  | Function   | Function to be called     | 1            |
| arguments | Expression | Arguments to the function | 0..*         |

**Table 72 – Function class**

| NAME       | TYPE                 | DEFINITION  | MULTIPLICITY |
|------------|----------------------|-------------|--------------|
| name       | string               | Name        | 1            |
| parameters | map < string, type > | Parameters  | 1            |
| returnType | type                 | Return type | 1            |

### 18.1.1.2. Standard functions

A standard function is a Function with a pre-determined set of parameters, return value and behavior that may be registered with a URI. Requirements class in this section defines standard functions.

**Table 73 – Standard functions URI mapping**

| KEY | VALUE    | DEFINITION  |
|-----|----------|---|
| uri | Function | A URI allows to identify standard functions, even if identical function names are used in different encoding, extension or implementations for different behaviors. |

## 18.1.2. Requirements

# 18.2. Requirements Class “Spatial Relation Functions”

---

## 18.2.1. Overview

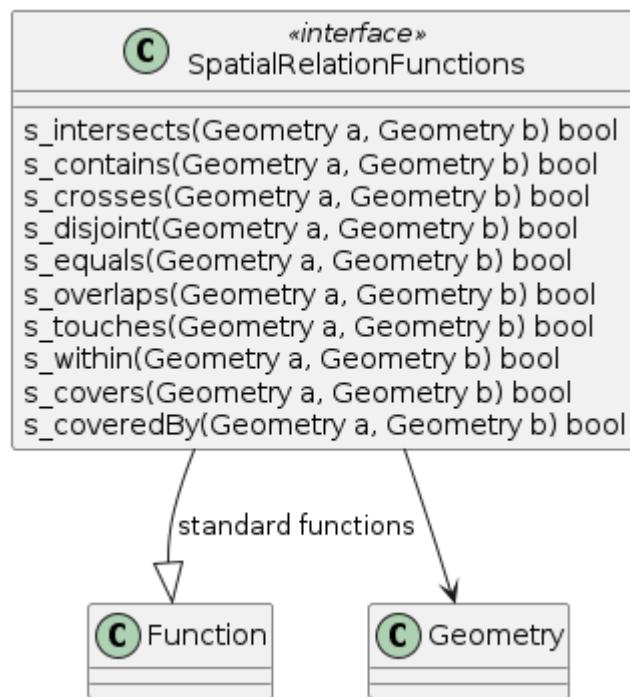


Figure 36 – Spatial Relation Functions UML Diagram

Table 74 – Spatial relation functions

| NAME         | PARAMETERS                           | RETURN TYPE | DEFINITION |
|--------------|--------------------------------------|-------------|------------|
| s_intersects | s_intersects(Geometry a, Geometry b) | bool        |            |
| s_contains   | s_contains(Geometry a, Geometry b)   | bool        |            |
| s_crosses    | s_crosses(Geometry a, Geometry b)    | bool        |            |
| s_disjoint   | s_disjoint(Geometry a, Geometry b)   | bool        |            |

| NAME        | PARAMETERS                          | RETURN TYPE | DEFINITION |
|-------------|-------------------------------------|-------------|------------|
| s_equals    | s_equals(Geometry a, Geometry b)    | bool        |            |
| s_overlaps  | s_overlaps(Geometry a, Geometry b)  | bool        |            |
| s_touches   | s_touches(Geometry a, Geometry b)   | bool        |            |
| s_within    | s_within(Geometry a, Geometry b)    | bool        |            |
| s_covers    | s_covers(Geometry a, Geometry b)    | bool        |            |
| s_coveredBy | s_coveredBy(Geometry a, Geometry b) | bool        |            |

### 18.2.1.1. Geometry System Identifiers



Figure 37 – Geometry System Identifiers UML Class Diagram

SpatialRelationFunctions are defined in the [OGC Simple Feature Access – Part 1: Common Architecture](#) specification and listed in the following table. They involve operations on geometries.

## 18.2.1.2. Geometry



Figure 38 – Geometry Classes UML Diagram

### 18.2.1.2.1. Bounding boxes

Although not a feature geometry per se, a bounding box is a valid Geometry argument for the spatial relation and geometry manipulation functions, and can describe the envelope of a Geometry.

Table 75 – BoundingBox class

| NAME       | DEFINITION                                    | TYPE  | MULTIPLICITY |
|------------|---|-------|--------------|
| lowerBound | Point with smallest value for each coordinate | Point | 1            |
| upperBound | Point with greatest value for each coordinate | Point | 1            |

### 18.2.1.2.2. Points

A Point is a 0-dimensional geometric object and represents a single location in coordinate space. A Point has an x-coordinate value, a y-coordinate value. If called for by the associated Spatial Reference System, it may also have coordinate values for z and m.

**Table 76** – Point class

| NAME        | DEFINITION  | TYPE   | MULTIPLICITY |
|-------------|-------------|--------|--------------|
| coordinates | coordinates | double | 2..*         |

The boundary of a Point is the empty set.

A MultiPoint is a geometry made of one or more Points.

The elements of a MultiPoint are restricted to Points. The Points are not connected or ordered in any semantically important way (see the discussion at GeometryCollection). A MultiPoint is simple if no two Points in the MultiPoint are equal (have identical coordinate values in X and Y). Every MultiPoint is spatially equal to a simple Multipoint. The boundary of a MultiPoint is the empty set.

**Table 77** – MultiPoint class

| NAME   | DEFINITION | TYPE  | MULTIPLICITY |
|--------|------------|-------|--------------|
| points | points     | Point | 2..*         |

### 18.2.1.2.3. Lines

A LineString is a curve with linear interpolation between Points. Each consecutive pair of Points defines a line segment.

**Table 78** – LineString class

| NAME   | DEFINITION                | TYPE  | MULTIPLICITY |
|--------|---------------------------|-------|--------------|
| points | Points in this LineString | Point | 2..*         |

A MultiLineString is a geometry made up of one or more LineStrings.

**Table 79** – MultiLineString class

| NAME        | DEFINITION                           | TYPE       | MULTIPLICITY |
|-------------|--------------------------------------|------------|--------------|
| lineStrings | Line strings in this MultiLineString | LineString | 1..*         |

#### 18.2.1.2.4. Polygons

A Polygon is a planar surface defined by 1 exterior boundary and 0 or more interior boundaries.

Each interior boundary defines a hole in the Polygon.

**Table 80 – Polygon class**

| NAME          | DEFINITION                    | TYPE       | MULTIPLICITY |
|---------------|-------------------------------|------------|--------------|
| exteriorRing  | Exterior ring of the polygon  | LinearRing | 1            |
| interiorRings | Interior rings of the polygon | LinearRing | 0..*         |

The exterior boundary LinearRing defines the “top” of the surface which is the side of the surface from which the exterior boundary appears to traverse the boundary in a counter clockwise direction. The interior LinearRings will have the opposite orientation, and appear as clockwise when viewed from the “top”.

The assertions for Polygons (the rules that define valid Polygons) are as follows:

- a) Polygons are topologically closed;
- b) The boundary of a Polygon consists of a set of LinearRings that make up its exterior and interior boundaries;
- c) No two Rings in the boundary cross and the Rings in the boundary of a Polygon may intersect at a Point but only as a tangent i.e.,

$$\forall P \in \text{Polygon}, \forall c1, c2 \in P.\text{Boundary}(), c1 \neq c2, \\ \forall p, q \in \text{Point}, p, q \in c1, p \neq q, \\ [p \in c2] \Rightarrow [\exists \delta > 0 \ni [|p-q| < \delta] \Rightarrow [q \notin c2]];$$

**Figure 39**

**NOTE**This last condition says that at a point common to the two curves, nearby points cannot be common. This forces each common point to be a point of tangency.

- d) A Polygon may not have cut lines, spikes or punctures i.e.,

$$\forall P \in \text{Polygon}, P = P.\text{Interior.Closure};$$

**Figure 40**

- e) The interior of every Polygon is a connected point set;
- f) The exterior of a Polygon with 1 or more holes is not connected. Each hole defines a connected component of the exterior.

In the above assertions, interior, closure and exterior have the standard topological definitions. The combination of (a) and © makes a Polygon a regular closed Point set. Polygons are simple geometric objects.

A Polygon is made of an exterior ring and zero or more interior rings.

A MultiPolygon is a Geometry made up of one or more Polygons.

**Table 81 – MultiPolygon class**

| NAME     | DEFINITION                | TYPE    | MULTIPLICITY |
|----------|---------------------------|---------|--------------|
| polygons | Polys of the multipolygon | Polygon | 1..*         |

The assertions for MultiPolygons are as follows.

- a) The interiors of 2 Polygons that are elements of a MultiPolygon may not intersect.

$$\forall M \in \text{MultiPolygon}, \forall P_i, P_j \in M.\text{Geometries}(), i \neq j, \\ \text{Interior}(P_i) \cap \text{Interior}(P_j) = \emptyset;$$

**Figure 41**

- b) The boundaries of any 2 Polygons that are elements of a MultiPolygon may not “cross” and may touch at only a finite number of Points.

$$\forall M \in \text{MultiPolygon}, \forall P_i, P_j \in M.\text{Geometries}(), \\ \forall c_i, c_j \in \text{Curve } c_i \in P_i.\text{Boundaries}(), c_j \in P_j.\text{Boundaries}() \\ \exists k \in \text{Integer} \ni c_i \cap c_j = \{ p_1, \dots, p_k \mid p_m \in \text{Point}, 0 < m < k \};$$

**Figure 42**

Note: Crossing is prevented by assertion (a) above.

- c) A MultiPolygon is defined as topologically closed.
- d) A MultiPolygon may not have cut lines, spikes or punctures, a MultiPolygon is a regular closed Point set:

$$\forall M \in \text{MultiPolygon}, M = \text{Closure}(\text{Interior}(M))$$

**Figure 43**

- e) The interior of a MultiPolygon with more than 1 Polygon is not connected; the number of connected components of the interior of a MultiPolygon is equal to the number of Polygons in the MultiPolygon.

The boundary of a MultiPolygon is a set of closed curves corresponding to the boundaries of its element Polygons. Each curve in the boundary of the MultiPolygon is in the boundary of exactly

1 element Polygon, and every curve in the boundary of an element Polygon is in the boundary of the MultiPolygon.

#### 18.2.1.2.5. Geometry collections

A GeometryCollection is a geometric object that is a collection of some number of geometric objects. All the elements in a GeometryCollection shall be in the same Spatial Reference System (the Spatial Reference System for the GeometryCollection).

**Table 82** – GeometryCollection class

| NAME       | DEFINITION                   | TYPE     | MULTIPLICITY |
|------------|------------------------------|----------|--------------|
| geometries | geometries in the collection | Geometry | 1..*         |

## 18.2.2. Requirements

# 18.3. Requirements Class “Temporal Relation Functions”

---

### 18.3.1. Overview

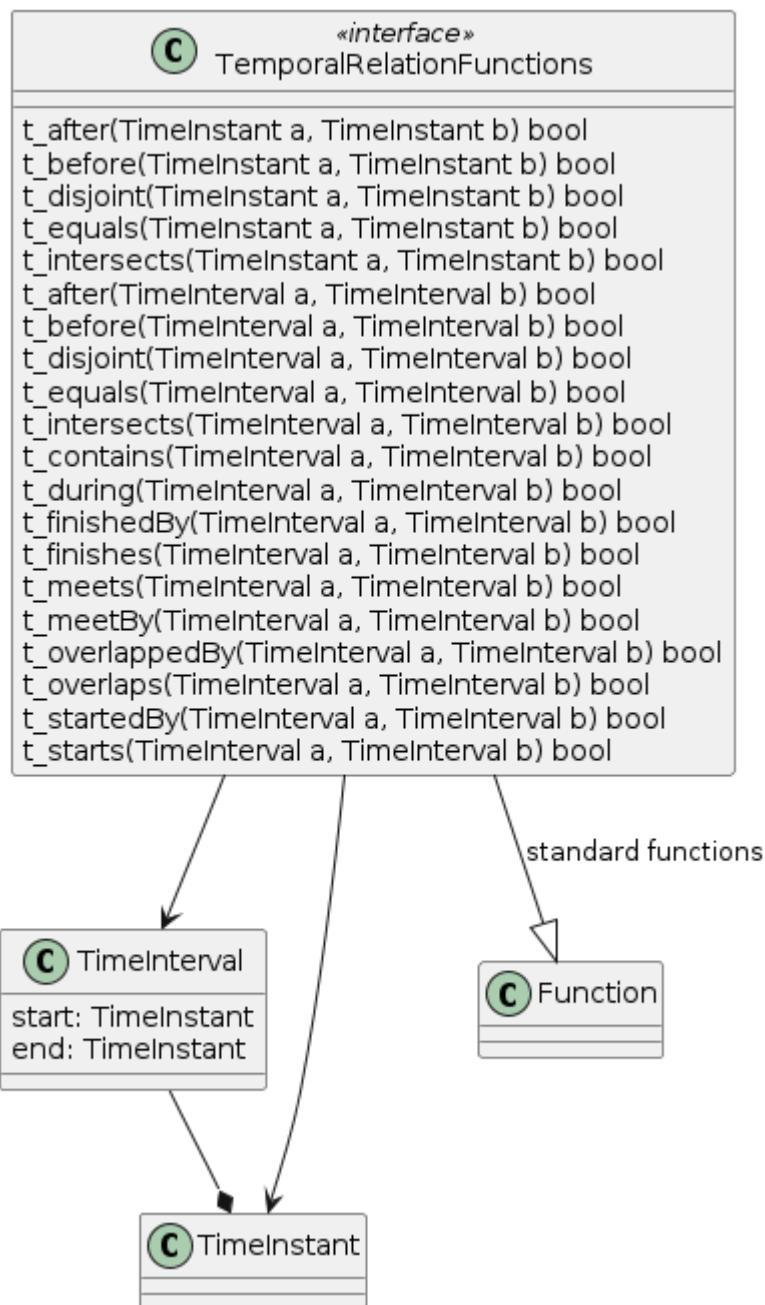


Figure 44 – Temporal Relation Functions UML Diagram

**Table 83** – TimeInterval class

| NAME  | DEFINITION            | DATA TYPE    | MULTIPLICITY |
|-------|-----------------------|--------------|--------------|
| start | start of the interval | TimelInstant | 1            |
| end   | end of the interval   | TimelInstant | 1            |

**Table 84** – Temporal relation functions acting on time instants

| NAME         | PARAMETERS                       | RETURN TYPE | DEFINITION |
|--------------|----------------------------------|-------------|------------|
| t_after      | (TimelInstant a, TimelInstant b) | bool        |            |
| t_before     | (TimelInstant a, TimelInstant b) | bool        |            |
| t_disjoint   | (TimelInstant a, TimelInstant b) | bool        |            |
| t_equals     | (TimelInstant a, TimelInstant b) | bool        |            |
| t_intersects | (TimelInstant a, TimelInstant b) | bool        |            |

**Table 85** – Temporal relation functions acting on time intervals

| NAME         | PARAMETERS                       | RETURN TYPE | DEFINITION |
|--------------|----------------------------------|-------------|------------|
| t_after      | (TimeInterval a, TimeInterval b) | bool        |            |
| t_before     | (TimeInterval a, TimeInterval b) | bool        |            |
| t_disjoint   | (TimeInterval a, TimeInterval b) | bool        |            |
| t_equals     | (TimeInterval a, TimeInterval b) | bool        |            |
| t_intersects | (TimeInterval a, TimeInterval b) | bool        |            |
| t_contains   | (TimeInterval a, TimeInterval b) | bool        |            |
| t_during     | (TimeInterval a, TimeInterval b) | bool        |            |
| t_finishedBy | (TimeInterval a, TimeInterval b) | bool        |            |

| NAME           | PARAMETERS                       | RETURN TYPE | DEFINITION |
|----------------|----------------------------------|-------------|------------|
| t_finishes     | (TimeInterval a, TimeInterval b) | bool        |            |
| t_meets        | (TimeInterval a, TimeInterval b) | bool        |            |
| t_meetBy       | (TimeInterval a, TimeInterval b) | bool        |            |
| t_overlappedBy | (TimeInterval a, TimeInterval b) | bool        |            |
| t_overlaps     | (TimeInterval a, TimeInterval b) | bool        |            |
| t_startedBy    | (TimeInterval a, TimeInterval b) | bool        |            |
| t_starts       | (TimeInterval a, TimeInterval b) | bool        |            |

### 18.3.2. Requirements

## 18.4. Requirements Class “Array Relation Functions”

---

### 18.4.1. Overview

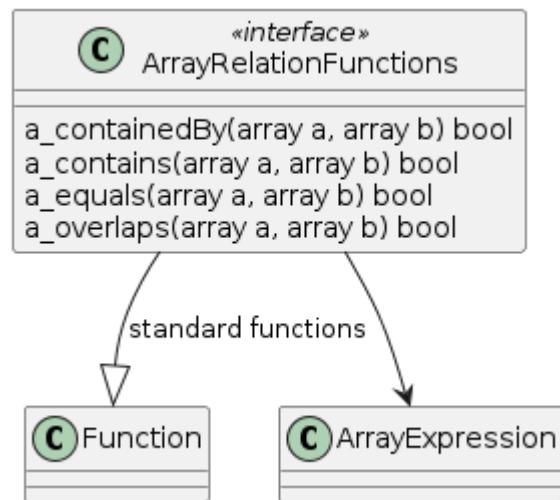


Figure 45 – Array Relation Functions UML Diagram

**Table 86 – Array relation functions**

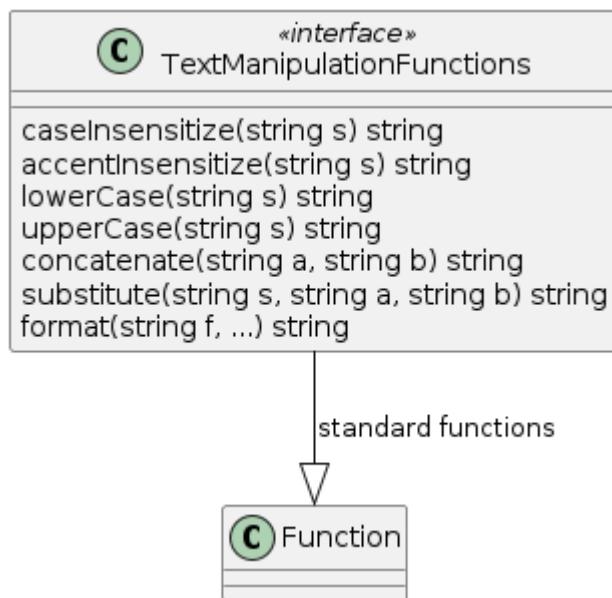
| NAME          | PARAMETERS         | RETURN TYPE | DEFINITION |
|---------------|--------------------|-------------|------------|
| a_containedBy | (array a, array b) | bool        |            |
| a_contains    | (array a, array b) | bool        |            |
| a_equals      | (array a, array b) | bool        |            |
| a_overlaps    | (array a, array b) | bool        |            |

### 18.4.2. Requirements

## 18.5. Requirements Class “Text Manipulation Functions”

---

### 18.5.1. Overview



**Figure 46 – Text Manipulation Functions UML Diagram**

**Table 87** – Text manipulation functions

| NAME              | PARAMETERS                     | RETURN TYPE | DEFINITION |
|-------------------|--------------------------------|-------------|------------|
| caseInsensitive   | (string s)                     | string      |            |
| accentInsensitive | (string s)                     | string      |            |
| lowerCase         | (string s)                     | string      |            |
| upperCase         | (string s)                     | string      |            |
| concatenate       | (string a, string b)           | string      |            |
| substitute        | (string s, string a, string b) | string      |            |
| format            | (string f, ...)                | string      |            |

## 18.5.2. Requirements

# 18.6. Requirements Class “Geometry Manipulation Functions”

---

## 18.6.1. Overview

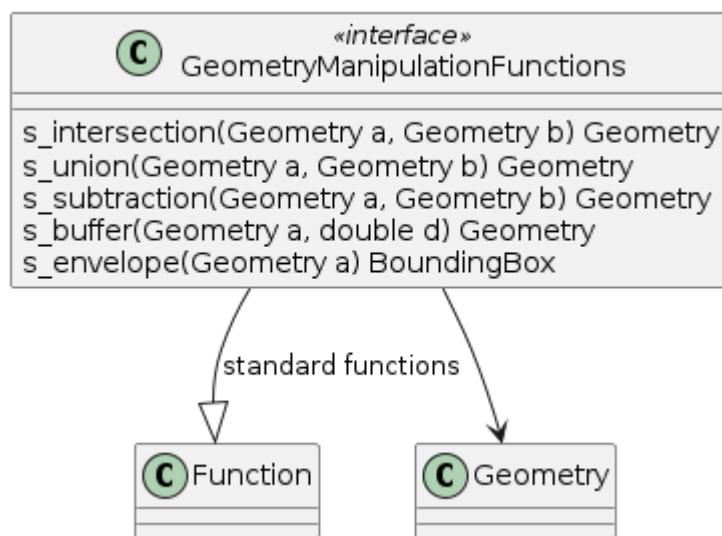


Figure 47 – Geometry Manipulation Functions UML Diagram

Table 88 – Geometry manipulation functions

| NAME                        | PARAMETERS                            | RETURN TYPE | DEFINITION |
|-----------------------------|---------------------------------------|-------------|------------|
| <code>s_intersection</code> | <code>(Geometry a, Geometry b)</code> | Geometry    |            |
| <code>s_union</code>        | <code>(Geometry a, Geometry b)</code> | Geometry    |            |
| <code>s_subtraction</code>  | <code>(Geometry a, Geometry b)</code> | Geometry    |            |
| <code>s_buffer</code>       | <code>(Geometry a, double d)</code>   | Geometry    |            |

## **18.6.2. Requirements**

19

# REQUIREMENTS CLASS “3D MODELS AND TRANSFORMS”

---

# REQUIREMENTS CLASS “3D MODELS AND TRANSFORMS”

## 19.1. Overview

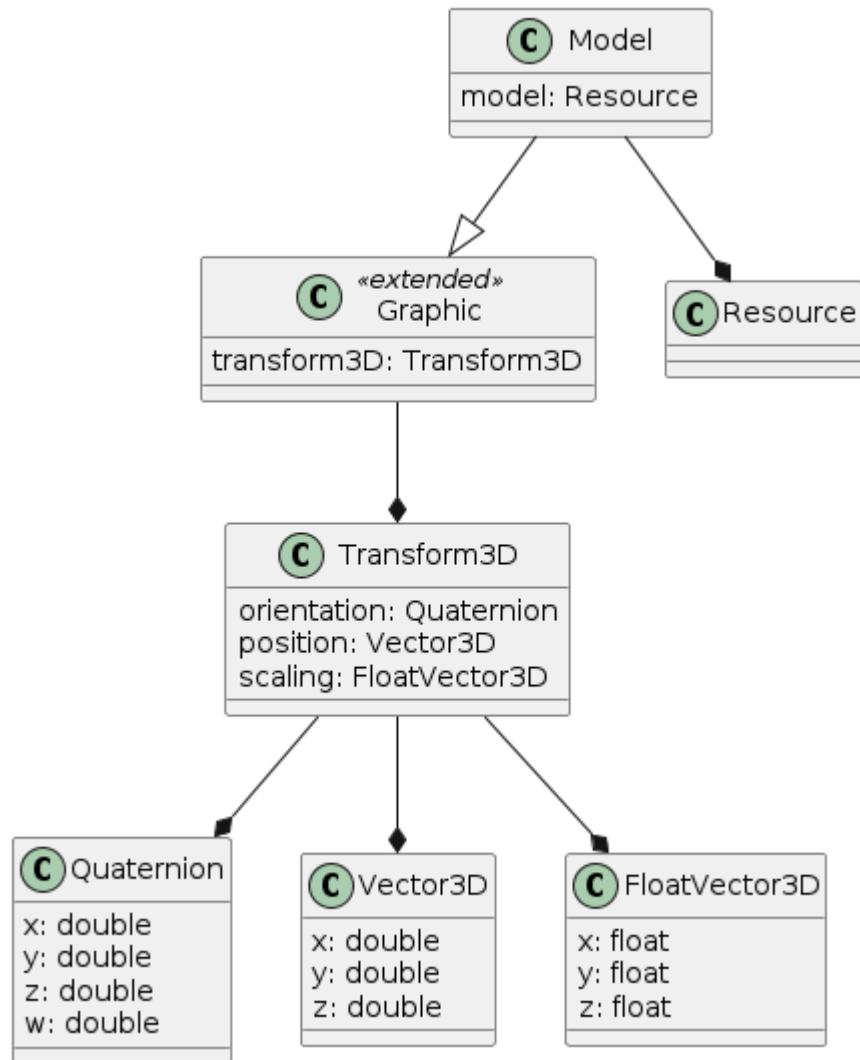


Figure 48

This requirements class adds support for 3D model Graphics as well as 3D transformations (position, orientation, and scaling) for Graphics.

**Table 89** – Extended Graphic class

| NAME        | DEFINITION        | TYPE        | MULTIPLICITY |
|-------------|-------------------|-------------|--------------|
| transform3D | 3D Transformation | Transform3D | 0..1         |

NOTE The 2D position, orientation and scaling properties defined in the *MultiGraphics* and *Transform* requirements class correspond to their equivalent components in the 3D transformation.

**Table 90** – Model class

| NAME  | DEFINITION            | TYPE     | MULTIPLICITY |
|-------|-----------------------|----------|--------------|
| model | Resource for 3D model | Resource | 1            |

**Table 91** – Transform3D class

| NAME        | DEFINITION  | DATA TYPE AND VALUE | MULTIPLICITY |
|-------------|-------------|---------------------|--------------|
| orientation | orientation | Quaternion          | 1            |
| position    | position    | Vector3D            | 1            |
| scaling     | scaling     | FloatVector3D       | 1            |

**Table 92** – Vector3D class

| NAME | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|------|--------------|---------------------|--------------|
| x    | x coordinate | double              | 1            |
| y    | y coordinate | double              | 1            |
| z    | z coordinate | double              | 1            |

**Table 93** – FloatVector3D class

| NAME | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|------|--------------|---------------------|--------------|
| x    | x coordinate | float               | 1            |

| NAME | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|------|--------------|---------------------|--------------|
| y    | y coordinate | float               | 1            |
| z    | z coordinate | float               | 1            |

**Table 94 – Quaternion class**

| NAME | DEFINITION   | DATA TYPE AND VALUE | MULTIPLICITY |
|------|--------------|---------------------|--------------|
| x    | x coordinate | double              | 1            |
| y    | y coordinate | double              | 1            |
| z    | z coordinate | double              | 1            |
| w    | w coordinate | double              | 1            |

## 19.2. Requirements

---

20

# REQUIREMENTS CLASS “JSON STYLES AND SYMOLOGY”

---

# REQUIREMENTS CLASS “JSON STYLES AND SYMOLOGY”

---

## 20.1. Overview

---

This requirements class defines a JSON encoding for the Styles and Symbology Logical Model. The primary objective of this encoding is to be readily parsable and writable by machines using a standard JSON parser. Styles encoded with this encoding are not easily hand-edited by cartographers.

## 20.2. Requirements

---

21

# REQUIREMENTS CLASS “CASCADING CARTOGRAPHIC SYMOLOGY STYLE SHEETS”

# REQUIREMENTS CLASS “CASCADING CARTOGRAPHIC SYMBOLOGY STYLE SHEETS”

---

## 21.1. Overview

---

This requirements class defines an encoding for the Styles and Symbology Logical Model inspired from Web Cascading Style Sheets (CSS) and other CSS-like cartographic symbology encodings. The primary objective of this encoding is to be easy to be expressive and facilitate hand-edition by cartographers. Parsing this encoding requires a custom parser.

### 21.1.1. Encoding a style

#### 21.1.1.1. Styling Rules

#### 21.1.1.2. Expressions

#### 21.1.1.3. Selectors

#### 21.1.1.4. Symbolizers

### 21.1.2. Examples

Example – CCSSS Example encoding style using “Core” requirements class

```
.title "Styling a land use layer"  
.abstract "Styling land use data with Style & Symbology Core"  
  
#Landuse[dataLayer.type = vector]  
{  
    visibility: false;  
  
    [viz.sd < 200000 and viz.date > DATE('2020-01-01')]  
    {  
        visibility: true;  
        opacity: 0.5;  
        zOrder: 1;  
    }  
}
```

```
}
```

### 21.1.2.1. Basic Vector Styling

Example – CCGSS Example encoding style using “Basic Vector Styling” requirements class

```
.title "Styling vector features"
.abstract "Basic vector features styling"

#Landuse[dataLayer.type = vector and dataLayer.featuresGeometryDimensions = 2]
{
    // Do not show Landuse layer by default
    visibility: false;

    // Show land use if zoomed in more than 1:200,000 for data valid within
    visualization's selected time range
    [viz.sd < 200000 and validDate >= viz.startDate and validDate <= viz.
    endDate]
    {
        visibility: true;
        opacity: 0.8;
        zOrder: 1;
        fill: (color: gray; opacity: 0.5);
        stroke: (color: gray; width: 2.0 px; opacity: 1.0);

        // Select different fill and stroke color based on FunctionCode property
        [FunctionCode = 'parking']
        {
            fill.color: darkGray;
            stroke.color = #202020;
        }
        [FunctionCode = 'park']
        {
            fill.color: darkGreen;
            stroke.color = green;
        }
        [FunctionCode = 'commercial']
        {
            fill.color: lightGray;
            stroke.color = lightGray;
        }

        // If zoomed in more than 1:10,000
        [viz.sd < 10000]
        {
            // Change stroke width to 4 pixels
            stroke.width = 4.0 px;
            // Add a text marker (positioned at centroid + horizontal offset)
            showing FunctionTitle property
            marker: (elements: (
                Text(
                    position: (20 0); // Offset 20 pixels to the right
                    text: FunctionTitle;
                    alignment: (left top);
                    font: (
                        face: 'Arial';
                        size = 14;
                        bold: true;
                        italic: true;
                        opacity: 1.0;
                        color: black;
```

```

        )
    );
// Add icons at centroid based on land use function code property
[FunctionCode = 'parking']
{
    +marker.elements: (
        Image(
            image: (uri: http://example.com/parkingIcon; path:
'parkingIcon.png'; id: 'parking'; type: 'image/png'; ext: 'png');
            hotSpot: (50 perc 50 perc); tint: white; blackTint: blue;
alphaThreshold: 0.1;
        )
    }
[FunctionCode = 'park']
{
    +marker.elements: (
        Image(
            image: (uri: http://example.com/park; path: 'park.png'; id:
'park'; type: 'image/png'; ext: 'png');
            hotSpot: (50 perc 50 perc); tint: white; blackTint: blue;
alphaThreshold: 0.1;
        )
    }
[FunctionCode = 'commercial']
{
    +marker.elements: (
        Image(
            image: (uri: http://example.com/commercial; path:
'commercial.png'; id: 'commercial'; type: 'image/png'; ext: 'png');
            hotSpot: (50 perc 50 perc); tint: white; blackTint: blue;
alphaThreshold: 0.1;
        )
    }
}
}

#Roads[dataLayer.type = vector and dataLayer.featuresGeometryDimensions = 1]
{
    visibility: false

    [viz.sd < 200000 and validDate >= viz.startDate and validDate <= viz.
endDate]
{
    visibility: true
    opacity: 0.8;
    zOrder: 2;
    stroke: (color: gray; width: 5.0 px; opacity: 1.0);

    // If zoomed in more than 1:10,000
    [viz.sd < 10000]
{
        // Change stroke width to 8 meters
        stroke.width = 8.0 m;
        // Add Dot at each segment end-point
        marker: (elements: (
            Dot(
                size: 10 m; // Alias for base Shape class stroke width
                color: white;
            )
        )));
}
}

```

```

        }
    }

#Amenities[dataLayer.type = 'vector' and dataLayer.featuresGeometryDimensions =
0]
{
    visibility: false

    [viz.sd < 200000 and validDate >= viz.startDate and validDate <= viz.
endDate]
    {
        visibility: true
        opacity: 0.5
        zOrder: 3

        // If zoomed in more than 1:10,000
        [viz.sd < 10000]
        {
            // Add a double-Dot marker (positioned at centroid)
            marker: (elements: (
                Dot( // larger white dot underneath
                    size: 10 px; // Alias for base Shape class stroke width
                    alignment: (center middle);
                    color: white;
                ),
                Dot( // smaller orange dot in center
                    size: 8 px; // Alias for base Shape class stroke width
                    alignment: (center middle);
                    color: orange;
                )
            )));
            [viz.sd < 5000]
            {
                // Add a Text graphic to Marker at 1:5000
                +marker.elements: (
                    Text(
                        position: (20 0); // Offset 20 pixels to the right
                        text: Name; // Name of Amenity
                        alignment: (left middle);
                        font: (
                            face: 'Arial';
                            size = 12;
                            bold: false;
                            italic: false;
                            opacity: 1.0;
                            color: darkGray;
                        )
                    )
                )
            }
        }
    }
}

```

### 21.1.2.2. Basic Coverage Styling

**Example 1 – CCSSS Example encoding style rendering DEM with a color map using “Basic Coverage Styling” requirements class**

```
.title "DEM with color map"
```

```

.abstract "Applying a color map to a Digital Elevation Model with Style &
Symbology Basic Coverage Styling"
#Elevation[dataLayer.type = coverage]
{
    visibility: false;

    [viz.sd < 200000]
    {
        visibility: true;
        opacity: 0.8;
        zOrder: 1;

        singleChannel: elevation; // Use elevation coverage field
        colorMap: (0 (96 136 73)), (900 (226 219 167)), (1300 (252 197 117)),
(1900 (254 168 134)), (2500, (250 250 250));
    }
}

```

**Example 2 – CCSSS Example encoding style rendering sentinel-2 in natural color from 3 bands using “Basic Coverage Styling” requirements class**

```

.title "sentinel-2 natural color"
.abstract "Styling a Sentinel-2A coverage with Style & Symbology Basic
Coverage Styling"
#Sentinel2L2A[dataLayer.type = coverage]
{
    visibility: false;

    [viz.sd < 200000]
    {
        visibility: true;
        opacity: 0.8;
        zOrder: 1;

        colorChannels: (r: B04; g: B03; b: B02);
        alphaChannel: 1.0;
        [SCL=8] { alphaChannel: 0.5; } // Reduce alpha channel value for
medium cloud probability
        [SCL=9] { alphaChannel: 0.0; } // Zero alpha channel value for high
cloud probability
    }
}

```

### 21.1.2.3. Arithmetic Operations (with Basic Coverage Styling)

**Example – CCSSS Example encoding style rendering NDVI with color map using “Basic Coverage Styling” requirements class**

```

.title "sentinel-2 natural color"
.abstract "Styling a Sentinel-2A coverage with Style & Symbology Basic
Coverage Styling"
#Sentinel2L2A[dataLayer.type = coverage]
{
    visibility: false;

    [viz.sd < 200000]
    {
        visibility: true;
        opacity: 0.8;
        zOrder: 1;

```

```
singleChannel: (B08 - B04)/(B08 + B04);
alphaChannel: 1.0;
[SCL=8] { alphaChannel: 0.5; } // Reduce alpha channel value for
medium cloud probability
[SCL=9] { alphaChannel: 0.0; } // Zero alpha channel value for high
cloud probability
colorMap: ((-1.0 saddleBrown),(0.0 peru),(0.2 goldenrod),(0.5 olive),(0.
6 yellowGreen),(0.8 greenYellow),(1.0 lime));
}
}
```

#### 21.1.2.4. Hill Shading

## 21.2. Requirements

---



A

# ANNEX A (NORMATIVE) ABSTRACT TEST SUITE

---

# ANNEX A (NORMATIVE) ABSTRACT TEST SUITE

A Symbology Encoding or Rendering Engine implementation shall satisfy at minimum the abstract tests of the “Core” conformance class to be conformant with this specification, and optionally the abstract tests of any number of additional conformance classes.

The root OGC URI identifier for the conformance classes of this Abstract Tests Suite is:

<http://www.opengis.net/spec/symbology-1/2.0/conf/>

## A.1. Conformance Class “Core”

### CONFORMANCE CLASS A.1

|             |   |
|-------------|---|
| IDENTIFIER  | <a href="http://www.opengis.net/spec/symbology-1/2.0/conf/core">http://www.opengis.net/spec/symbology-1/2.0/conf/core</a> |
| SUBJECT     | Requirements Class “Core”   |
| TARGET TYPE | Encoding<br>Rendering engine  |

### ABSTRACT TEST A.1

|              |  |
|--------------|--|
| IDENTIFIER   | /conf/core/rules                       |
| REQUIREMENT  | Requirement 1: /req/core/rules         |
| TEST PURPOSE | Validate the encoding of styling rules |
| TEST METHOD  | Given:<br>When:<br>Then:               |

## A.2. Conformance Class “Basic Vector Features Styling”

---

### CONFORMANCE CLASS A.2

**IDENTIFIER** <http://www.opengis.net/spec/symbology-1/2.0/conf/vector>

**SUBJECT** Requirements Class “Basic Vector Features Styling”

**TARGET TYPE** Encoding  
Rendering engine

### ABSTRACT TEST A.2

**IDENTIFIER** /conf/vector/stroke

**REQUIREMENT** Requirement 21: /req/vector/stroke

**TEST PURPOSE** Validate the encoding of a symbolizer stroke

**TEST METHOD** Given:  
When:  
Then:

## A.3. Conformance Class “Basic Coverage Styling”

---

### CONFORMANCE CLASS A.3

**IDENTIFIER** <http://www.opengis.net/spec/symbology-1/2.0/conf/coverage>

**SUBJECT** Requirements Class “Basic Coverage Styling”

**TARGET TYPE** Encoding  
Rendering engine

## ABSTRACT TEST A.3

|              |   |
|--------------|---|
| IDENTIFIER   | /conf/coverage/color-channels                       |
| REQUIREMENT  | Requirement 29: /req/coverage/color-channels        |
| TEST PURPOSE | Validate the encoding of a symbolizer colorChannels |
| TEST METHOD  | Given:<br>When:<br>Then:                            |



B

## ANNEX B (INFORMATIVE) MAPPING OF SLD/SE AND NOTABLE VENDOR EXTENSIONS TO THE CONCEPTUAL MODEL

## ANNEX B (INFORMATIVE)

### MAPPING OF SLD/SE AND NOTABLE VENDOR EXTENSIONS TO THE CONCEPTUAL MODEL

---

This annex maps constructs of the OGC Styled Layer Descriptor (SLD) and Symbology Encoding (SE) 1.1 to the conceptual model and requirements classes defined in this Standard, with the goal of facilitating conformance to this Standard for Rendering engines based on SLD/SE and writing conversion tools that can convert in either or both direction between SLD/SE and the two encodings defined in this Standard.

C

# ANNEX C (INFORMATIVE) PORTRAYAL USE CASES GALLERY

---

## ANNEX C (INFORMATIVE) PORTRAYAL USE CASES GALLERY

---

This annex illustrates the capabilities of the different requirements classes defined in this standard with a map gallery of practical use cases alongside the styles used to generate the maps encoded in the *Cascading Styles and Symbology Stylesheets* encoding defined in this Standard.

D

# ANNEX D (INFORMATIVE) REVISION HISTORY

---

## ANNEX D

### (INFORMATIVE)

### REVISION HISTORY

---

**Table D.1 — Revision history**

| DATE       | RELEASE AUTHOR   | PARAGRAPH MODIFIED | DESCRIPTION   |
|------------|--|--------------------|---|
| 2020-08-27 | E. Bocher (CNRS) O. Ertz (HEIG-VD)                                     |                    | Edits considering received and answered comments from TC vote |
| 2019-09-18 | E. Bocher (CNRS) O. Ertz (HEIG-VD)                                     |                    | Edits considering received and answered comments (18-067r2)   |
| 2019-08-21 | E. Bocher (CNRS) O. Ertz (HEIG-VD)                                     |                    | Update abstract to be more comprehensive                      |
| 2019-03-29 | E. Bocher (CNRS) O. Ertz (HEIG-VD)                                     |                    | Edits considering received and answered comments              |
| 2018-09-07 | E. Bocher (CNRS) O. Ertz (HEIG-VD)                                     |                    | Release for early public comment (18-067)                     |
| 2018-06-05 | E. Bocher (CNRS) O. Ertz (HEIG-VD)                                     |                    | Initial document  |
| 2022-12-01 | E. Bocher (CNRS) O. Ertz & M. Collombin (HEIG-VD), J. St-Louis (Ecere) |                    | Initial work towards version 2.0                              |
| 2023-02-23 | E. Bocher (CNRS) O. Ertz & M. Collombin (HEIG-VD), J. St-Louis (Ecere) |                    | Progress towards 2.0 in preparation for 125th MM in Frascati  |



# BIBLIOGRAPHY

---



## BIBLIOGRAPHY

---

This Standard is deeply inspired by the work from the following documents that preceded it:

- [1] Stephane Fellah: OGC 16-059, *Testbed-12 Semantic Portrayal, Registry and Mediation Engineering Report*. Open Geospatial Consortium (2017). <https://docs.ogc.org/per/16-059.html>.
- [2] Jeff Yutzler, Rob Cass: OGC 17-094r1, *OGC Portrayal Concept Development Study*. Open Geospatial Consortium (2018). <https://docs.ogc.org/per/17-094r1.html>.
- [3] Stephane Fellah: OGC 17-045, *OGC Testbed-13: Portrayal Engineering Report*. Open Geospatial Consortium (2018). <https://docs.ogc.org/per/17-045.html>.
- [4] Jérôme Jacovella-St-Louis: OGC 18-025, *OGC Testbed-14: CityGML and AR Engineering Report*. Open Geospatial Consortium (2019). <https://docs.ogc.org/per/18-025.html>.
- [5] Sara Saeedi: OGC 18-029, *OGC Testbed-14: Symbology Engineering Report*. Open Geospatial Consortium (2019). <https://docs.ogc.org/per/18-029.html>.
- [6] Martin Klopfer: OGC 19-018, *OGC Testbed-15: Open Portrayal Framework Engineering Report*. Open Geospatial Consortium (2020). <https://docs.ogc.org/per/19-018.html>.
- [7] Martin Klopfer: OGC 19-019, *OGC Testbed-15: Portrayal Summary ER*. Open Geospatial Consortium (2020). <https://docs.ogc.org/per/19-019.html>.
- [8] Bocher E, Ertz O. 2018. A redesign of OGC Symbology Encoding standard for sharing cartography. PeerJ Computer Science 4:e143, <https://doi.org/10.7717/peerj-cs.143>