# System Property

## SEBoK Definition

Any named, measurable or observable attribute, quality or characteristic of a system or system element. (OMG 2003) [3, SEBoK Glossary]

## Property value use across Life Cycle

The values of a system property evolve across its lifecycle as described below

1. As Specified (e.g., target values)
   1. Required Values – Property values specified by a stakeholder, e.g. the maximum power usage will be less than 100 W.
   2. Planned Values – Specified values at specific milestones. The final planned value may be more stringent than the required value specified by the stakeholder, e.g. the maximum power usage will be less than 90 W
2. As Designed– Values resulting from the analysis of the design
3. As Tested, As Manufactured, As Deployed, As Maintained – Measured values from a built product
4. Variance Values capture:
   1. Differences between the as specified, as designed, as measured, etc.
   2. Individual unit’s variation over time, environmental conditions, etc.
   3. Unit to Unit differences of as-built units

## System Property Attributes

1. Property Name –
   1. Allow special characters, e.g. &, %,-, #,\*, @,), (, etc.
2. Unique ID
   1. UUID
   2. URL (Uniform Resource Locator)
      1. Include property path for deeply nested properties [32]
3. Property Definition
   1. A textual description of the property
   2. This text has all the characteristics defined in the text sting type (see below)
4. Property Classification – Mechanical, Electrical, Thermal, etc. [4]. A property may have one or more property classifications.
5. Property Context – identifies what the property is a characteristic of (e.g., element, function, behavior, state, flow, expression, another property,) [3], [23]
6. Types of values captured including:[5]
   1. Integer
   2. Real
   3. Complex
   4. Boolean - True or False
   5. Enumeration - Discrete set of values
   6. String Values[34] - The value consists of text characters with all the formatting features found in a word processor such as multiple lines of text, multiple paragraphs, paragraph formats, character fonts, indentation, bulleted lists, number lists, punctuation, special character insertion, etc.
      1. Text can be inserted in-line with the text strings via hyperlinks to other text sources internal and external to the model including hyperlinks to other properties, property attributes values.
7. Numerical Value Types Attributes
   1. Unit and Quantity Kind(i.e. dimension)[6]
      1. Including dimensionless or % or monetary symbols (e.g. $, €, £)
      2. Include English and Metrics unit/quantity kind systems
   2. Value Range (>= minimum value and <= maximum value) [7]
   3. Accuracy, i.e. (+/- 0.1%) or (+2% to -1.5%) or (-2, +1)
   4. Probability distribution [24]
8. Property Structure
   1. A property can contain multiple values and can be composed of multiple properties
   2. Need to support
      1. Array and Matrix of Values [16]
      2. Scalar, Vector, and Tensor quantities [15]
   3. Multiplicity - A list of values or properties may be ordered and/or unique [17]
   4. Property grouping: Ability to create logical grouping of properties that can be allocated/assigned to an element, function, behavior, flow, expression ... (e.g. mechanical properties, optical properties)
   5. Property path: To designate the path of the property for deeply nested properties [32]
   6. Redefinition: Ability to over-ride (e.g., redefine) an inherited property
   7. Subsetting: Ability to select a subset from a property with multiplicity greater than one
9. Time Varying versus Constant Value Properties: [8], [22]
   1. Time Property
      1. A property with time related units and quantity kind (i.e. TOD, duration, time stamp, etc.) [39], [11]
   2. Time Varying Properties (e.g., state variables) – [9]
      1. Continuous and time discrete expressions [12]
      2. Provides the ability to specify initial conditions [10]
   3. Constants for all time (e.g. Pi)
   4. Properties that have a fixed value for a particular configuration (e.g., mass)
10. Expressions and constraints
    1. Comparison symbol operators, such as equals (=), greater than (>), less than (<), equal to and greater than (>=), and equal to and less than (<=) e.g. m >10, =15, <=20 [18]
    2. Logical/Boolean operators (e.g. AND, OR, NOT, NAND, NOR, etc.) [19]
    3. Declarative and procedural expressions [21]
    4. The expression can designate output properties (e.g., dependent or derived) versus the input properties (e.g., independent). [14], [22]
    5. State dependent property values, e.g. power consumption in the on and off state. [13]
    6. Provides a means to define the expression language [20]
    7. Supports the ability to express symbols and notations of the defined language, including;
       1. All standard mathematical operator notations, superscripts and subscripts, parenthesis, etc.
       2. Support notations for:
          1. Calculus notations and symbols such as differential and integral expressions
          2. Algebraic, geometry, trigonometry notations
          3. Array, matrix notations
          4. Complex functions
11. Links to analysis results [33]
    1. Includes links to graphs, tables, reports, data file, another visualization tool, etc. [31]
    2. Link Values
       1. Specify link format standard:
       2. Link to an external data set or value captured in another model, tool or database, such as an analysis result
       3. The type of these values for “from” properties should be defined remotely
12. Property Metadata
    1. Designation of critical properties such as technical measures that have planned values at defined milestones [27] (KPP, MOE, MOP, etc.)
    2. Security Classification – Enumerated list. In US, can be Top Secret, Secret, Confidential, Restricted, Protect, Unclassified, or (as of April 2014) TS, S, Official. These classifications can vary significantly from country to country so it will have to be adaptable
    3. Ownership – Control permissions providing read/write access to a person or groups
    4. Life Cycle Value Classification – e.g., as-specified, as-designed, as-manufactured, as-fielded, etc. [28]
    5. Source - a reference to a document where this information originated. [30]
13. Questions
    1. URL Questions
       1. Are the URN identifies useful also?
       2. Is the URL sufficient to provide referring to and establishing relationships to deeply nested properties
    2. Are the following attributes Metadata?
       1. Property Definition
       2. Property Classification
       3. Property Context
       4. Milestone (new) – references a defined milestone
    3. Are other numerical bases needed? Octal, binary, etc. If so add a Number base attribute
    4. Are other computer based information storage word, etc. (is “word” in ISO 80000? Byte, octet and bit are defined)
    5. Is Time a unique value type? (time is currently a quantity kind)
    6. In the Time attribute, sub-bullets c & d, do they apply for just time?
    7. Links – Two uses
       1. Can a Property value be a link? If so, is it a value type?
       2. Can they be used to populate a value of a property?
    8. Should a property be reusable (not just its type)
    9. Clarify the relationship of physical property to quantity kind? Should a library of physical properties be provided as noted in Wikipedia at: <https://en.wikipedia.org/wiki/Physical_property> [38]

## UML 2.5 References

**9.5 Properties**

**9.5.1 Summary**

Properties are StructuralFeatures that represent the attributes of Classifiers, the memberEnds of Associations, and the parts of StructuredClassifiers.

**11.4 Class**

**11.4.3.1 Classes**

Class is a kind of EncapsulatedClassifier whose Features are Properties, Operations, Receptions, Ports and Connectors.

Attributes of a Class are Properties that are owned by the Class. Some of these **attributes** may represent the ends of binary Associations.

## UPDM Specification

**8.3.1.1.2.5.5 Measurement**

MODAF: MeasurableProperty: A property of something in the physical world, expressed in amounts of a unit of measure. The property may have a required value - either specified by the [defaultValue] from UML::property attribute, or the [minValue] and [maxValue] to specify a required range. DoDAF: Measure: A Measurement (DoDAF::Measure) is the magnitude of some attribute of an individual.



**8.3.1.1.2.5.7 Property**

UPDM: The defining feature of an actual property, used to capture measurements



# Misc. Notes

1. To do that a property needs to be able to capture multiple sets of related values where each set is used for a specific domain need to help manage development towards their end goals. Domains can include, various analysis domains, V&V, project management, etc.
2. Each set:

* Is owned by someone or some group and they control the r/w permissions
* Has multiple values
* Each value has a unique identification
* May be properties within a set and those properties may have sets associated with them.
  + The value of interest may require supporting information, i.e. other variables, to qualify it.
  + Test data linked or captured, e.g.
    - The specification for the maximum engine temperature may require a test set to contain additional information other than the measured temperature. Additional information could include the physical geometric position or sensor ID to help understand where the maximum temperature was exceeded or not. Or maybe a record time to understand when it was taken within the set.

1. Property Set attributes – Each set has a set of attributes
   1. Set Name – unique across other sets
   2. Event within the set that uniquely distinguishes it from other values within the set, i.e. time stamp, TOD (date/time), time duration since previous measurement, milestone, unique number, sequential number, etc.
   3. Example sets:
      1. As is, as built, as shipped,
      2. Electrical, mechanical, thermal, etc.
2. Examine reference from Conrad for RFC for SysML/PI&IF Simulation Model Extension