Observation of a Smiley Face

Introduction

In this document, we provide an overview of the OGC/ISO Observations, measurements and samples (OMS) standard (ISO 19156). The core example has been abstracted from the usual use cases for OMS, often pertaining to measurements on specific media. To illustrate the applicability of OMS, we use the example of determining the color of a smiley face sticker. The same mechanisms utilizes here can be applied to a wide range of topics such as:

- Ozone concentration of the air at a point
- Nitrate concentration of a water sample
- Consistency of a soil sample
- Temperature of a room
- State of a traffic light

In the final section of this document, we provide some real-world examples of the use of OMS.

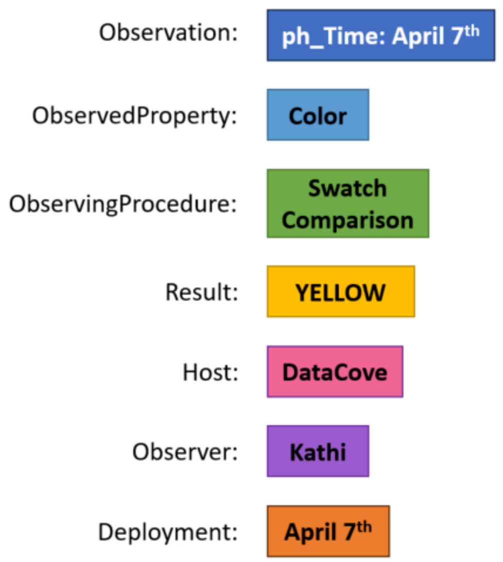
Symbology

Within this document, we utilize a simplified representation of UML object diagrams. In order to avoid overloading the diagrams with text, we define a few conventions here.

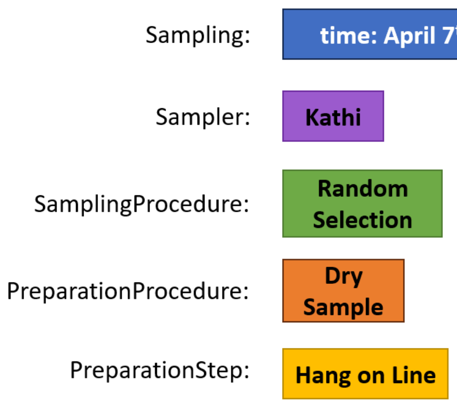
While we are aware that color coding can cause issues for the colorblind, the advantages for the color-sighted outweigh this issue. In order to make it possible for the colorblind to follow, the legend includes the text provided in the main diagrams.

Classes and Objects

In our simplified UML object diagram representation, all objects are depicted as rectangles. The legend below shows the color scheme used to differentiate between the classes of the OMS model, e.g. dark blue rectangles represent instances (objects) of the OMS Observation class.
For the Observation part of the OMS model, the following legend applies:



For the Sampling part of the OMS model, the following legend applies:



Literals

In our simplified UML object diagram representation, all literals (e.g. simple strings) are depicted as ovals, as shown in the figure below.

Observation of a Smiley Face

The simplest form of an Observation is a simple attribute that carries information on an object (feature). In our example, we're observing the color and expression of a smiley face sticker. In the simplest form, the object has the two attributes "Color" and "Expression", with the values YELLOW and HAPPY respectively, as shown in both Figure A and Codebox A.

Figure A: Smiley with simple attributes.

```
{
"color": "Yellow",
"expression": "Happy"
}
```

Codebox A: JSON representation of Smiley with simple attributes.

This all works well as long as no additional information needs to be provided together with the attribute. However, if one must provide additional qualifiers to the attribute such as the Procedure used to ascertain the value, this becomes difficult, as shown in Figure B.

Figure B: Smiley with floating Procedure.

This is where the OMS Observation comes into play, as this class is designed to collect all relevant information on how an observation was performed, giving often necessary context to the resulting value. Figure C shows how the Observation can be used to bring the Procedure from above into context.

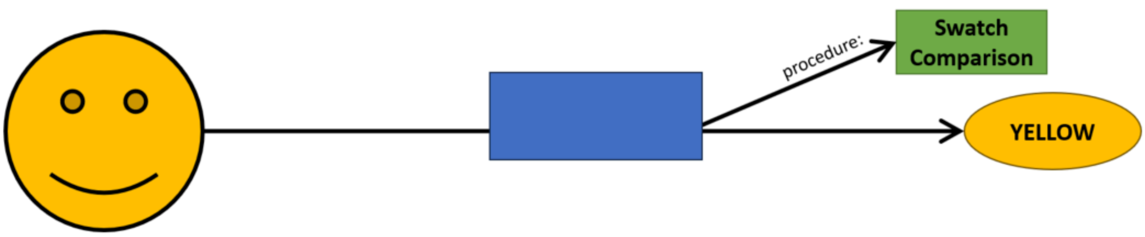


Figure C: Introduction of Observation.

However, now that we have introduced the Observation, we've lost the information on what exactly the attribute represents, in this example color. Thus, we must add an additional association ObservedProperty to the Observation to convey this information, as shown in Figure D.

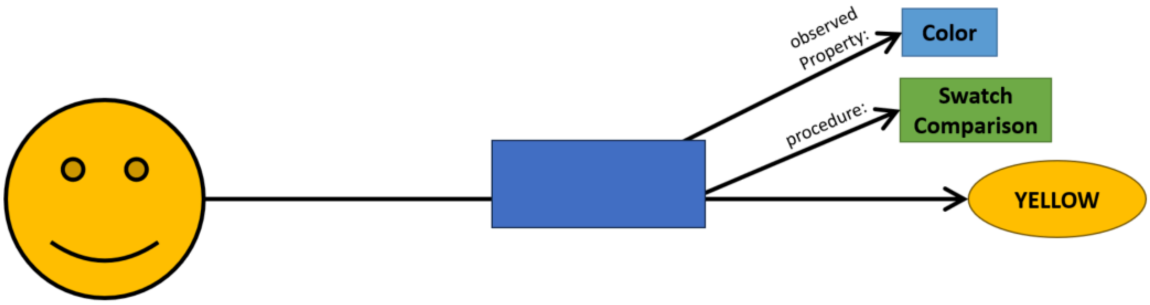


Figure D: Second version of Observation.

In order to complete the picture of the basic Observation, a few loose ends need to be tied off. The association to the Result, in this case "YELLOW", gets the association role "Result", while the association to the Smiley Face, the object of the Observation, gets the association role "FeatureofInterest", as shown in Figure E. This is in line with the Observation concept from O&M.

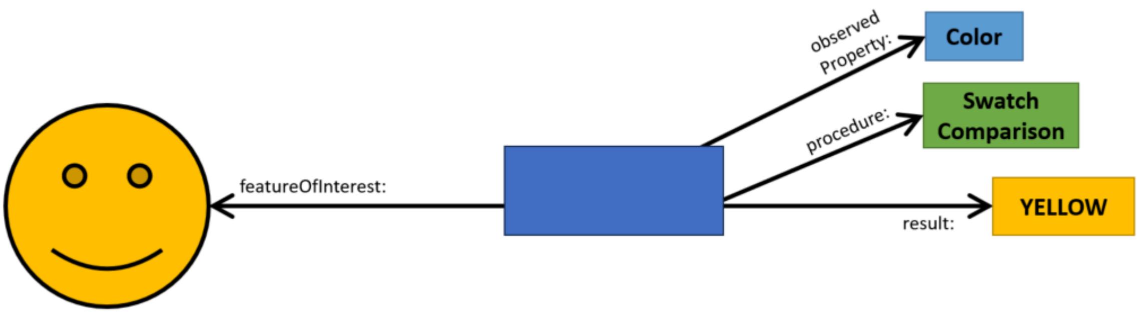


Figure E: Complete basic Observation.

Within OMS, some additional concepts have been introduced. The first is the "Observer", the entity that made the "Observation". This can be a sensor or alternatively a human being as shown in Figure F.

The addition of the "Observer" gives us an answer to the old question under O&M of if the Procedure should describe the abstract process performed or the explicit device performing the measurement. The "Observer" describes the explicit device while the "Procedure" describes the abstract process performed.

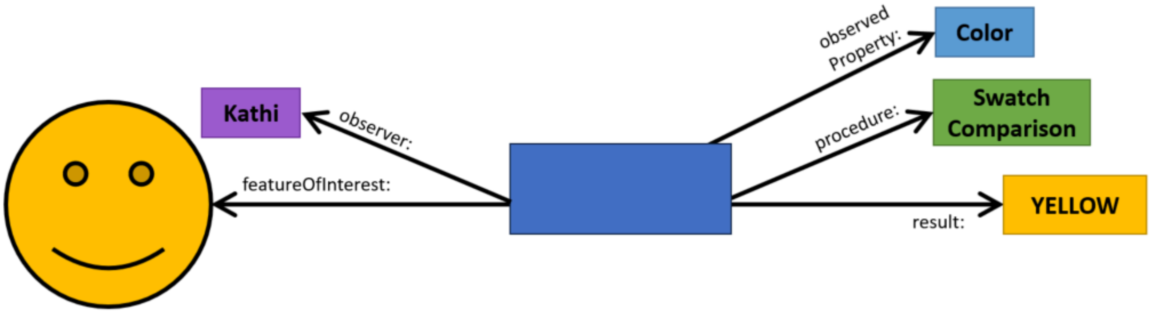


Figure F: Observation with Observer.

In many cases, there is some sort of facility hosting a set of sensors at a specific location. Similarly, when humans perform observations, this is often done in the context of a specific survey or regular monitoring. In order to provide information on such a facility or similar organisational grouping of Observers, in OMS the concept of “Host” was introduced as shown in Figure G.

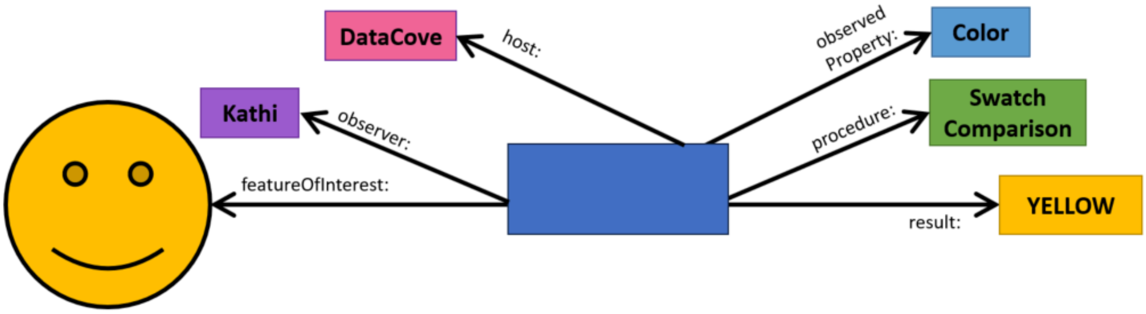


Figure G: Observation with Host.

A further addition in OMS is the “Deployment” Class, providing information on when which “Observer” has been deployed at which “Host”, as shown in Figure H.

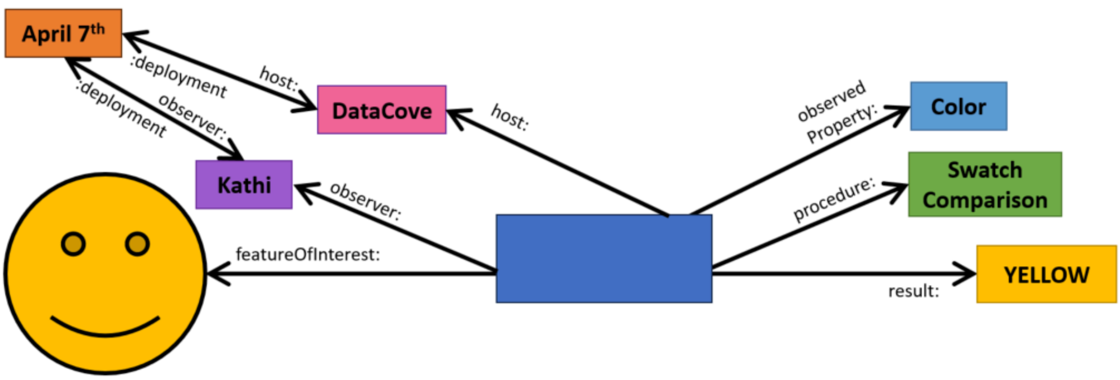


Figure H: Observation with Deployment.

A further essential qualification enabled by the OMS “Observation” pertains to time. The following times can be provided within an “Observation”:

- phenomenonTime: The time for which the result applies to the characteristic of the FeatureOfInterest being observed.
- resultTime: The instant of time when the result of the Observation became available.
- validTime: The time interval during which the result is assumed to be applicable for use.

All of these temporal attributes can be time periods, required for the provision of time-series as shown in Figure I.

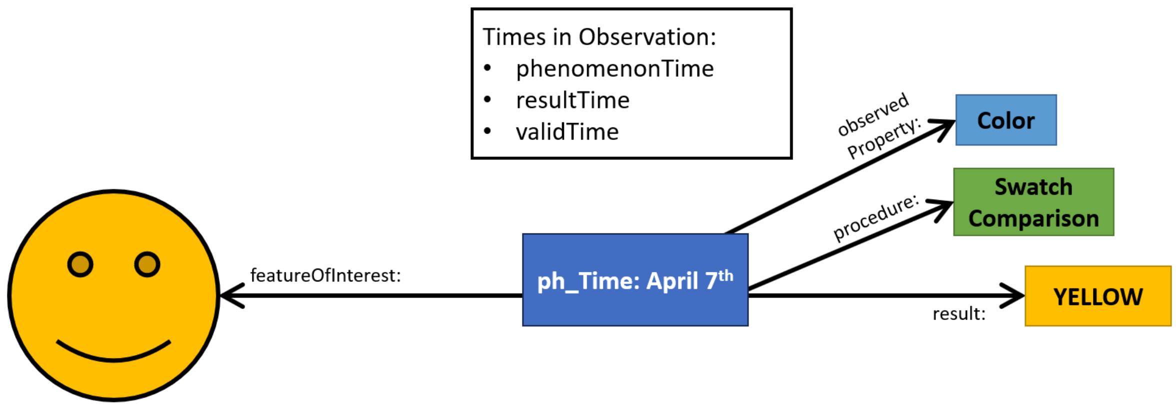


Figure Ia: Observation with time.

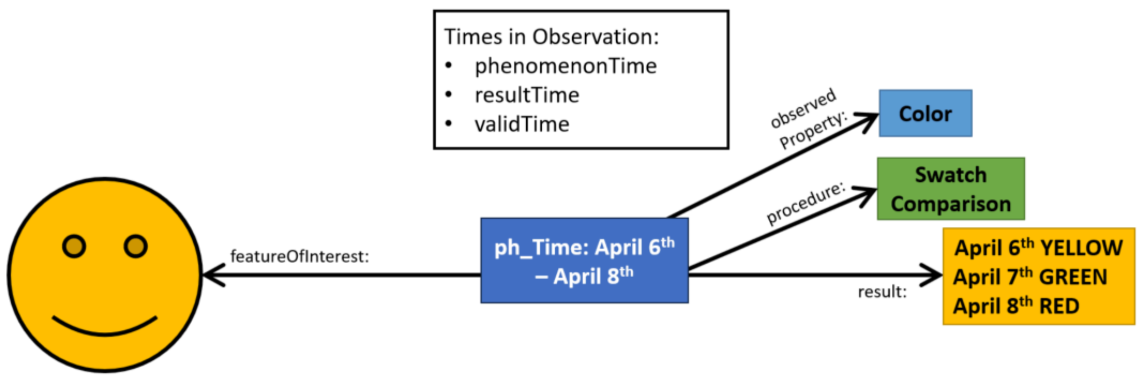


Figure Ib: Observation with time-series.

A final addition to the OMS “Observation” pertains to specialisations of the featureOfInterest, this has been subtyped to:

- proximateFeatureOfInterest: The entity that is directly of interest in the act of observing.
- ultimateFeatureOfInterest: The entity that is ultimately of interest in the act of observing.

In our example, the ProximateFeatureOfInterest is the Smiley Face Sticker, while the UltimateFeatureOfInterest could be a wider population of Smiley Face Stickers the one Smiley Face Sticker can be seen to be representative of as shown in Figure J.

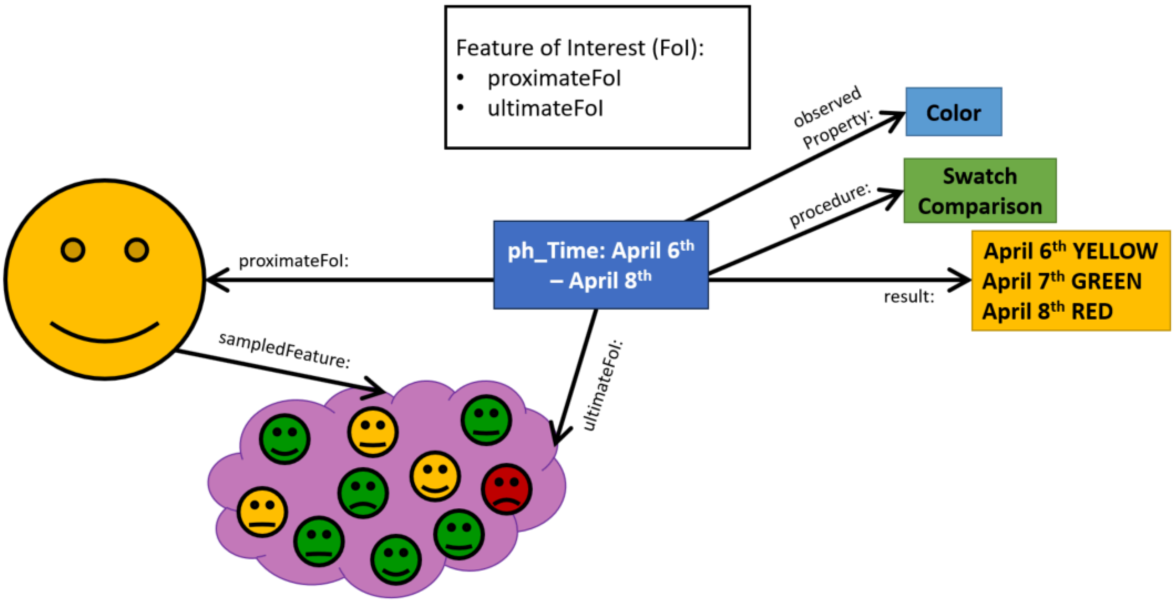


Figure J: Observation with proximate- and ultimateFeatureOfInterest

Sampling

Understanding how the object serving as the feature of interest of an Observation has been selected is often essential in understanding the quality and robustness of data. The OMS Sample model is designed to represent all relevant aspects of both sample selection as well as preparation steps performed on the sample.

Continuing our example, we will investigate how the Smiley Face Sticker under consideration has been selected from the wider population of Smiley Face Stickers as well as preparation steps taken to this Smiley Face Sticker before performing the Observation as described above. The Smiley Face Sticker and population of Smiley Face Stickers are associated with the sampledFeature relationship as shown in Figure K.

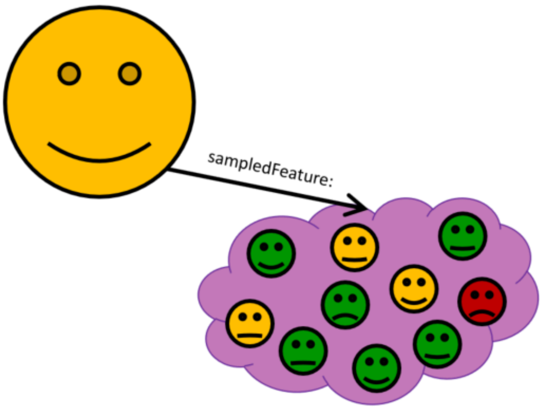


Figure K: Sample with Sampled Feature

In order to provide more explicit information on the sampling act, we add a “Sampling” object as shown in Figure L. In addition to indicating the time of the sampling act, “Sampling” is linked to the “Sample”(s) created by this sampling act via the “sample” association as well as the the concept, real-world object or phenomenon the “Sample”(s) of the “Sampling” represent indicated as “featureOfInterest”. The “sampledFeature” association can be seen as a shorthand notation of the more complex “Sampling” approach.

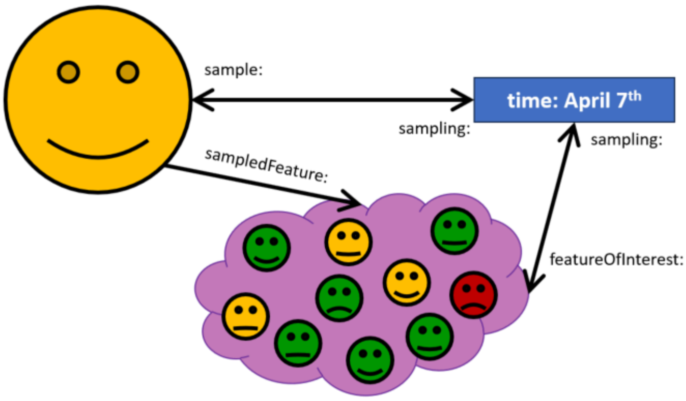


Figure L: Sample with Sampling

The “Sampling” provides information on both the “SamplingProcedure” utilized in the sampling act as well as the “Sampler”, the device or entity (including humans) that is used by or implements said “SamplingProcedure” to create or transform one or more “Sample”(s). In our example the “SamplingProcedure” ‘random selection’ is utilized by our “Sampler” ‘Kathi’ as shown in Figure M.

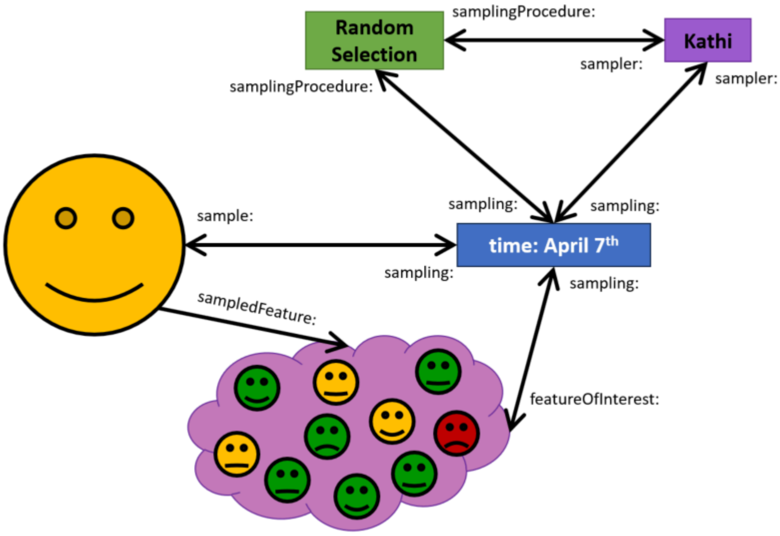


Figure M: Sampling with SamplingProcedure and Sampling

In many cases, some preparatory steps must be performed before an “Observation” can be performed on a “Sample”. In our example, it is important that the Smiley Face Sticker is dry before we determine the color, as a wet sticker may have a different color.

To this purpose OMS allows one to link various “PreparationStep” objects to a sample, whereby each “PreparationStep” can link to multiple “PreparationProcedure” objects describing individual procedures performed upon the “Sample”. In our example we show a “PreparationStep” ‘Dry Sample’ that implements the “PreparationProcedure” ‘Hand on Line’ as shown in Figure N.

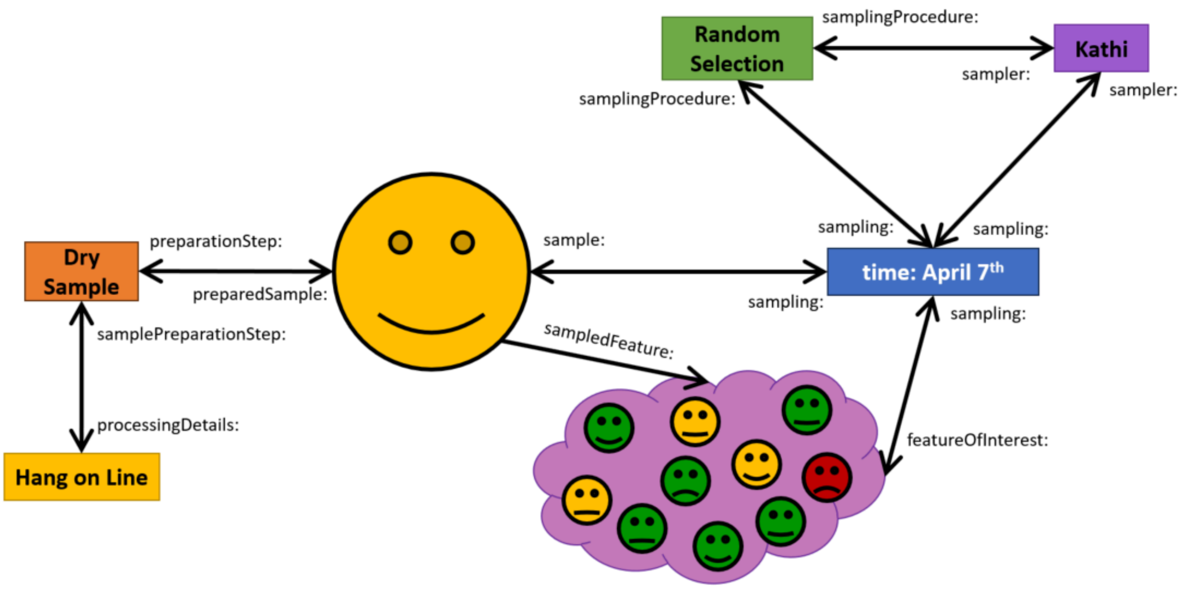
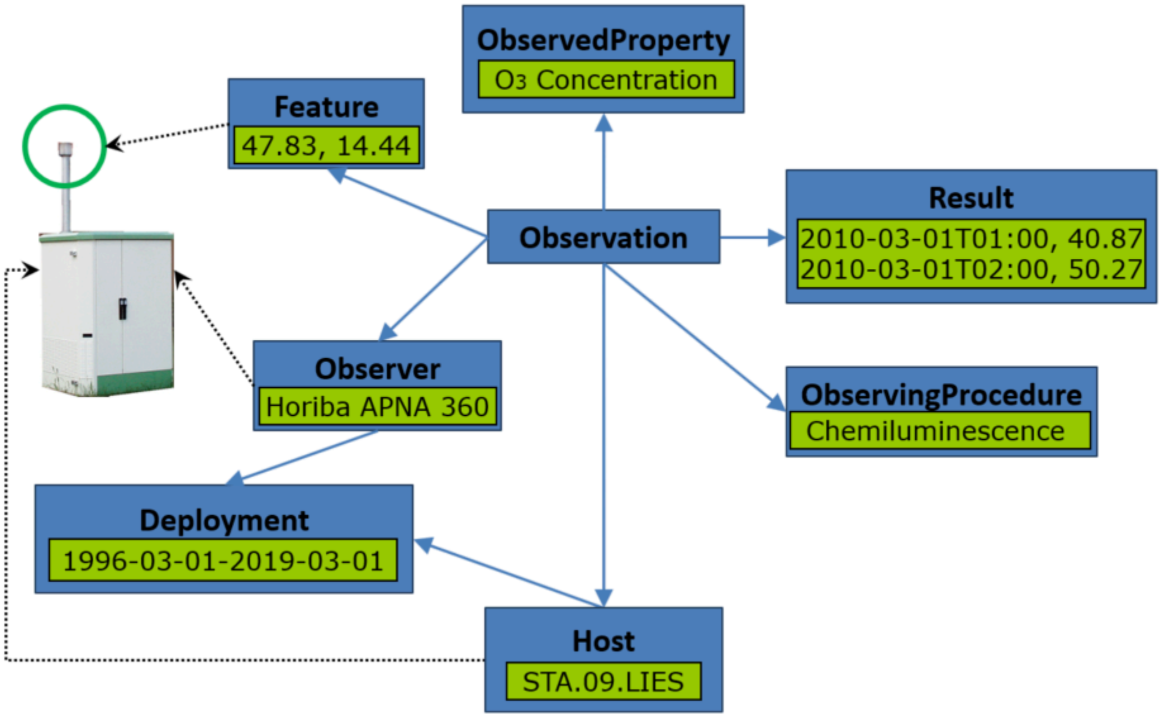


Figure N: Sample with PreparationStep and PreparationProcedure

Observations applied to Environmental Media

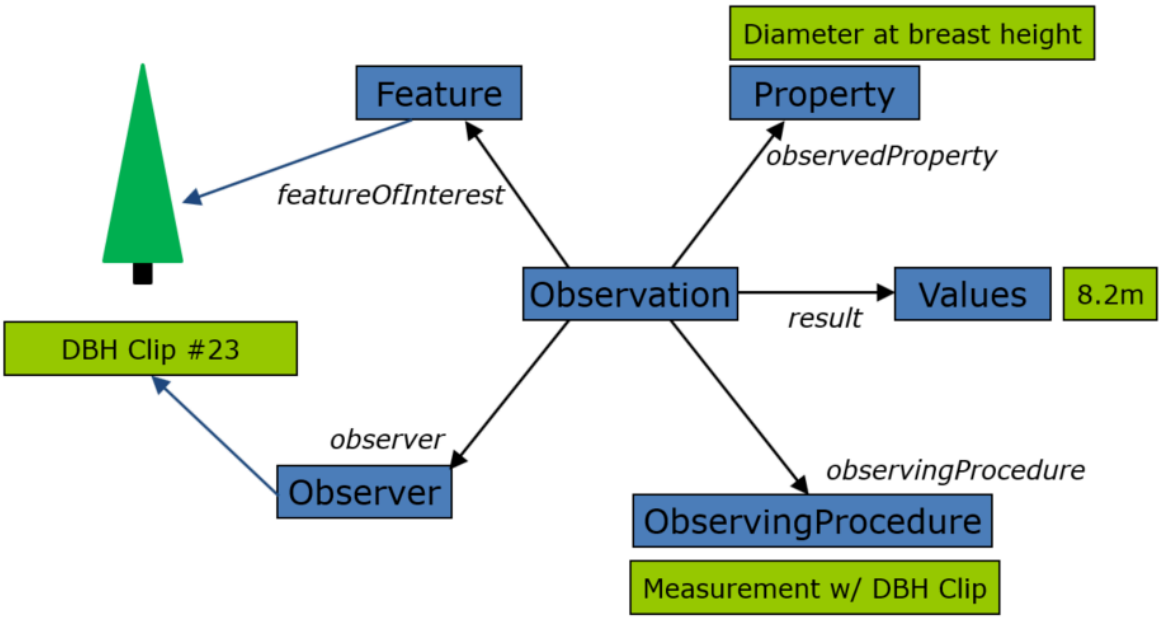
Air Quality Observation Examples

Observation of Ozone Concentration at an Air Quality Station



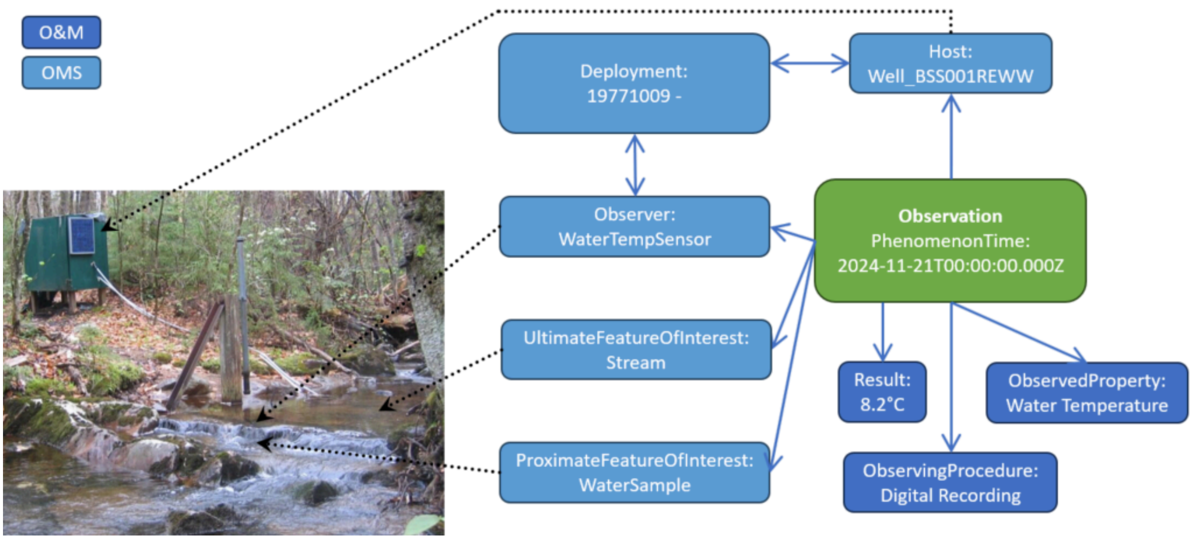
Biodiversity Observation Examples

Breast Height Diameter of a Tree

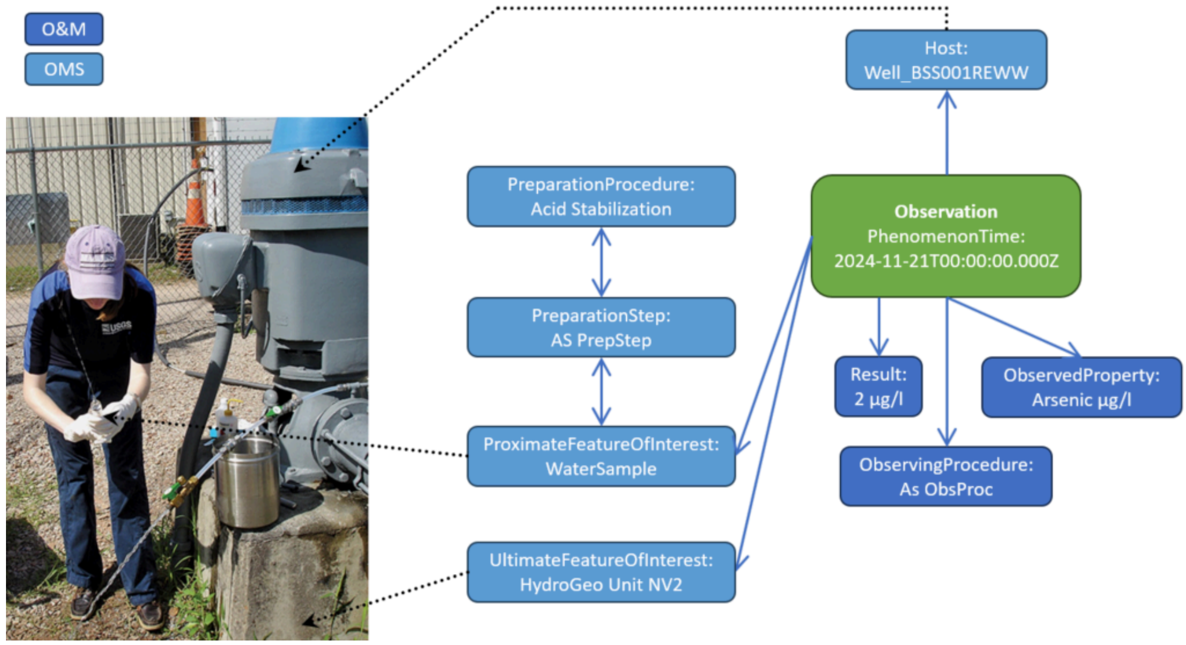


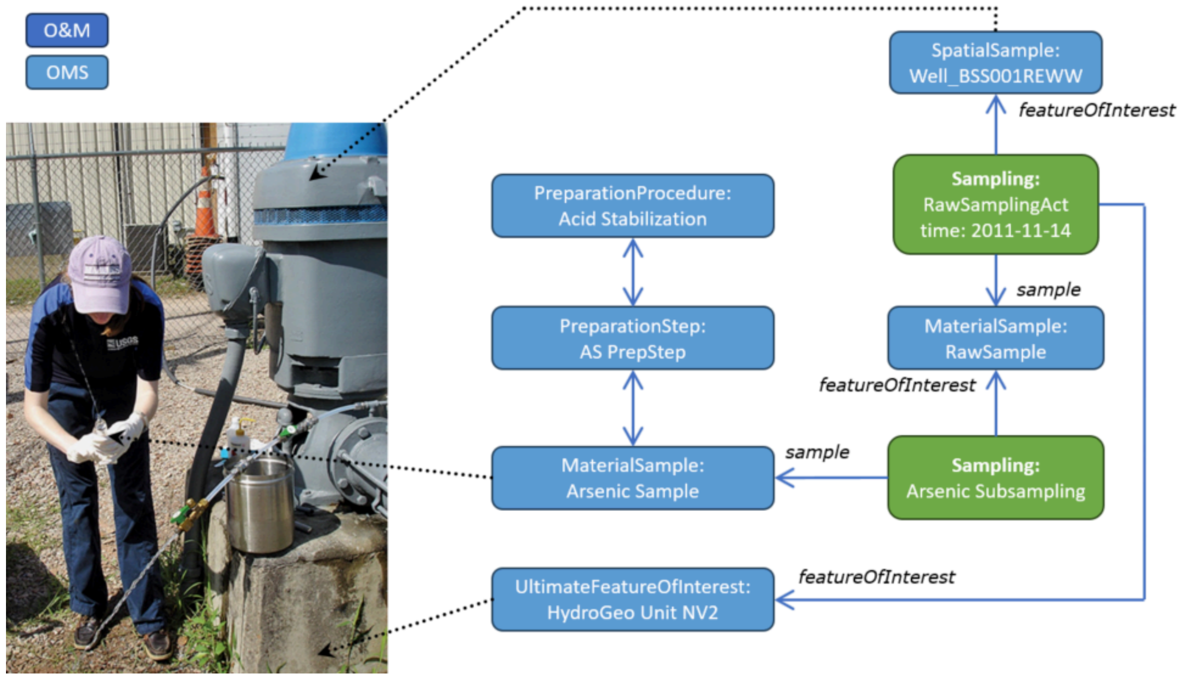
Water Quality Observation Examples

Surface water *in situ* Temperature



Ground Water ex situ Arsenic





Soil Observation Examples

Observation of average precipitation on a Soil Plot

Figure 3 : Observation of average precipitation on a Soil Plot shows how information on average precipitation can be provided for a Soil Plot. The featureOfInterest associates the Observation with a specific Soil Plot. The observedProperty references a codelist indicating that the Observation will provide information on average precipitation. The procedure indicates that a rain gauge has been used to determine the precipitation. The result shows that the average precipitation on the plot under investigation in the given year was 1434mm.

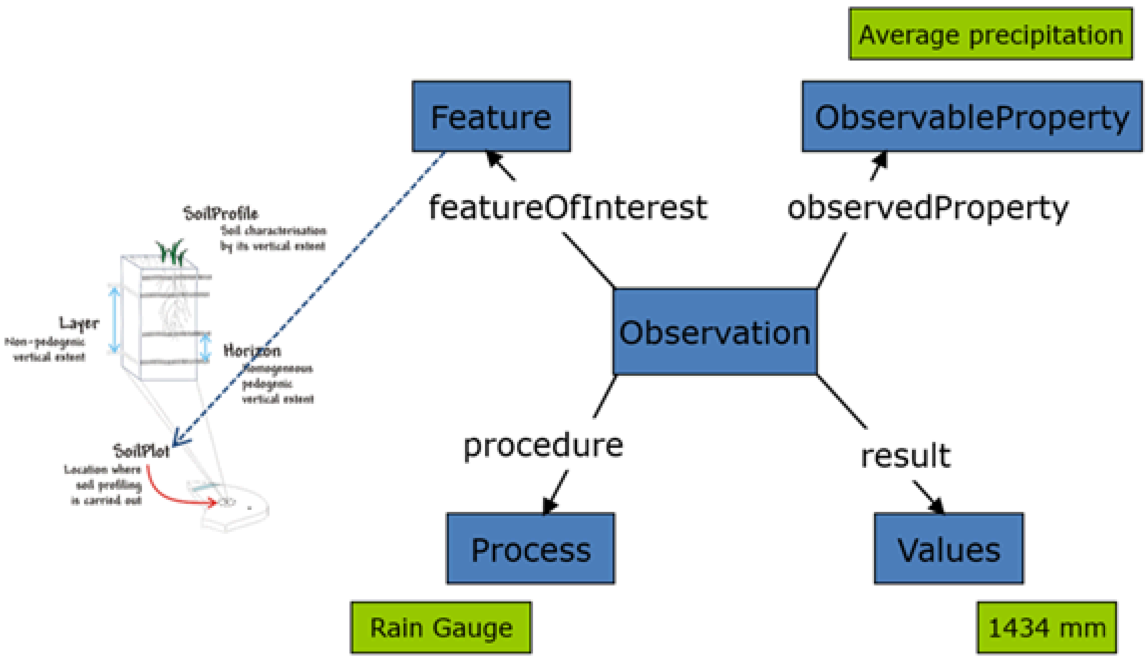


Figure 3: Observation of average precipitation on a Soil Plot

Observation of the effective soil depth on a Soil Profile

Figure 4: Observation of the effective soil depth on a Soil Profile shows how information on the effective soil depth can be provided for a Soil Profile. The featureOfInterest associates the Observation with a specific Soil Profile. The observedProperty references a codelist indicating that the Observation will provide information on the effective soil depth. The procedure indicates that this value has been determined in line with the requirements from ICP Forest. The result shows that the effective soil depth on the profile under investigation in the given year was 314cm.

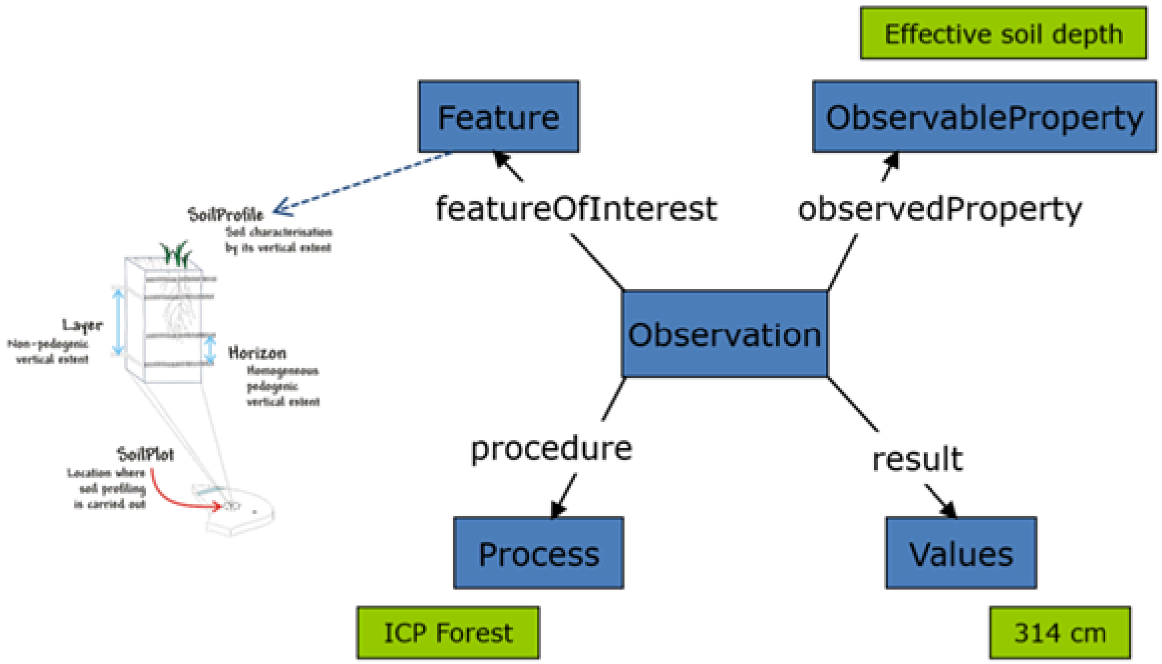


Figure 4: Observation of the effective soil depth on a Soil Profile

Observation of the percentage of clay in a Soil Horizon

Figure 5: Observation of the percentage of clay in a Soil Horizon shows how information on the percentage of clay can be provided for a Soil Horizon. The featureOfInterest associates the Observation with a specific Soil Horizon. The observedProperty references a codelist indicating that the Observation will provide information on the percentage of clay. The procedure indicates that this value has been determined by expert judgement. The result shows that the percentage of clay on the horizon under investigation in the given year was 30%.

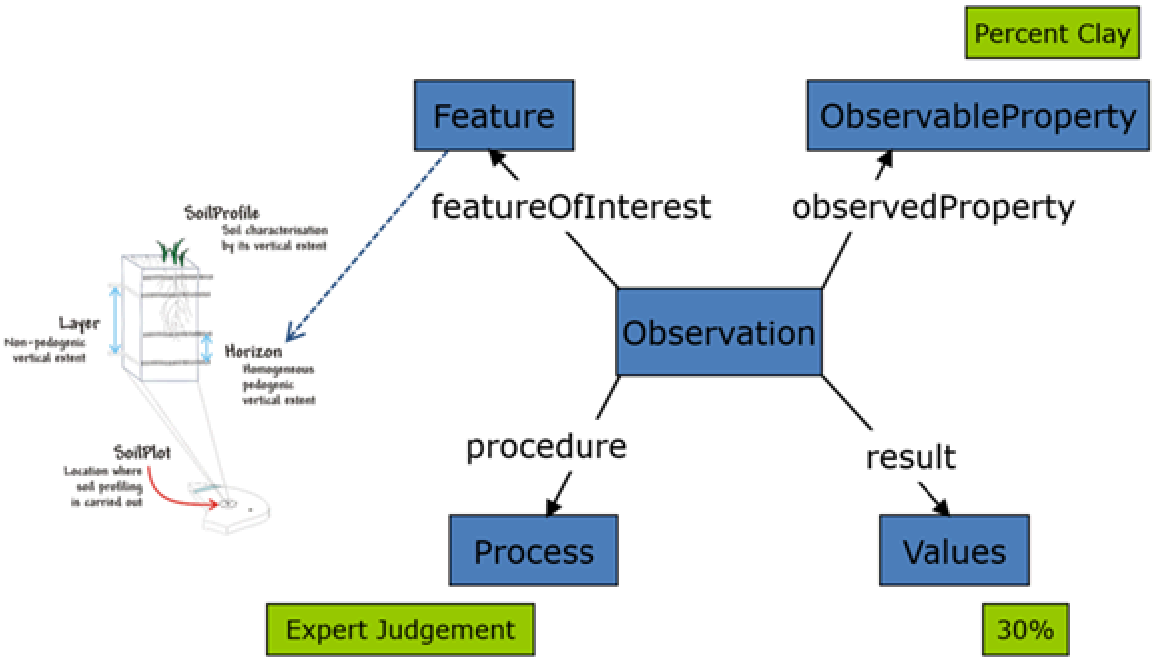


Figure 5: Observation of the percentage of clay in a Soil Horizon

Observation of the textural class of a Soil Layer

Figure 6: Observation of the textural class of a Soil Layer shows how information on the textural class can be provided for a Soil Layer. The featureOfInterest associates the Observation with a specific Soil Layer. The observedProperty references a codelist indicating that the Observation will provide information on the textural class. The procedure indicates that this value has been determined by expert judgement. The result shows that the textural class on the layer under investigation in the given year was 30%.

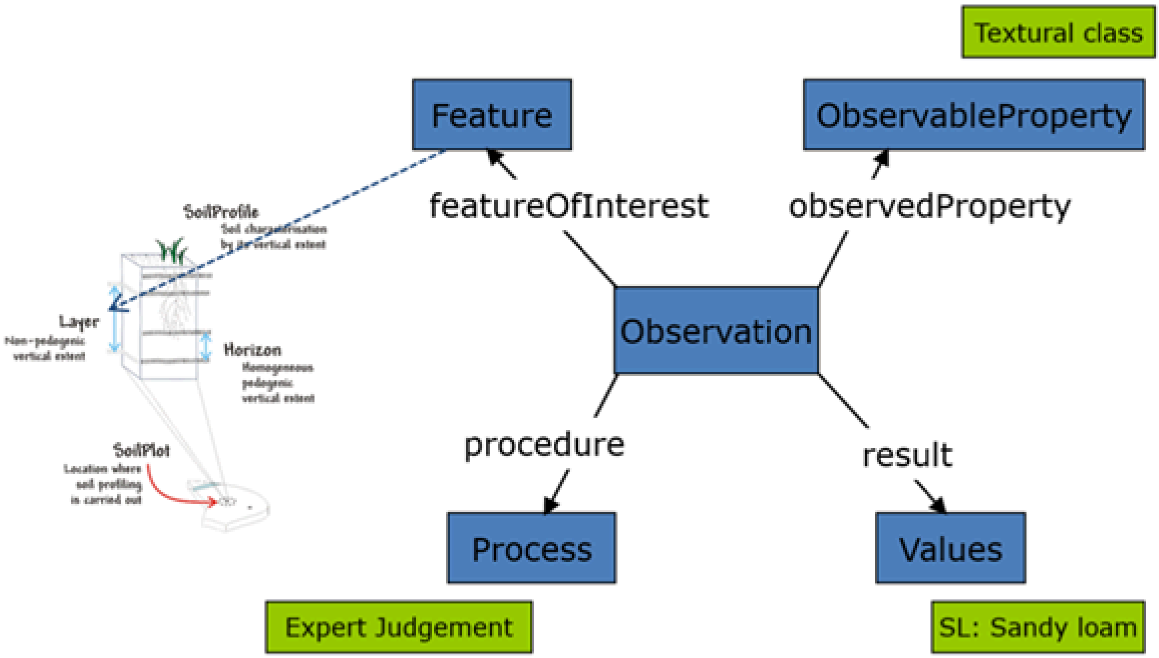


Figure 6: Observation of the textural class of a Soil Layer

Observation of the pH of a Soil Layer

Figure 7: Observation of the pH of a Soil Layer shows how information on the pH can be provided for a Soil Layer. The featureOfInterest associates the Observation with a specific Soil Layer. The observedProperty references a codelist indicating that the Observation will provide information on the pH. The procedure indicates that this value has been determined in accordance with ISO 10390:2005. The result shows that the textural class on the layer under investigation in the given year was 6.4.

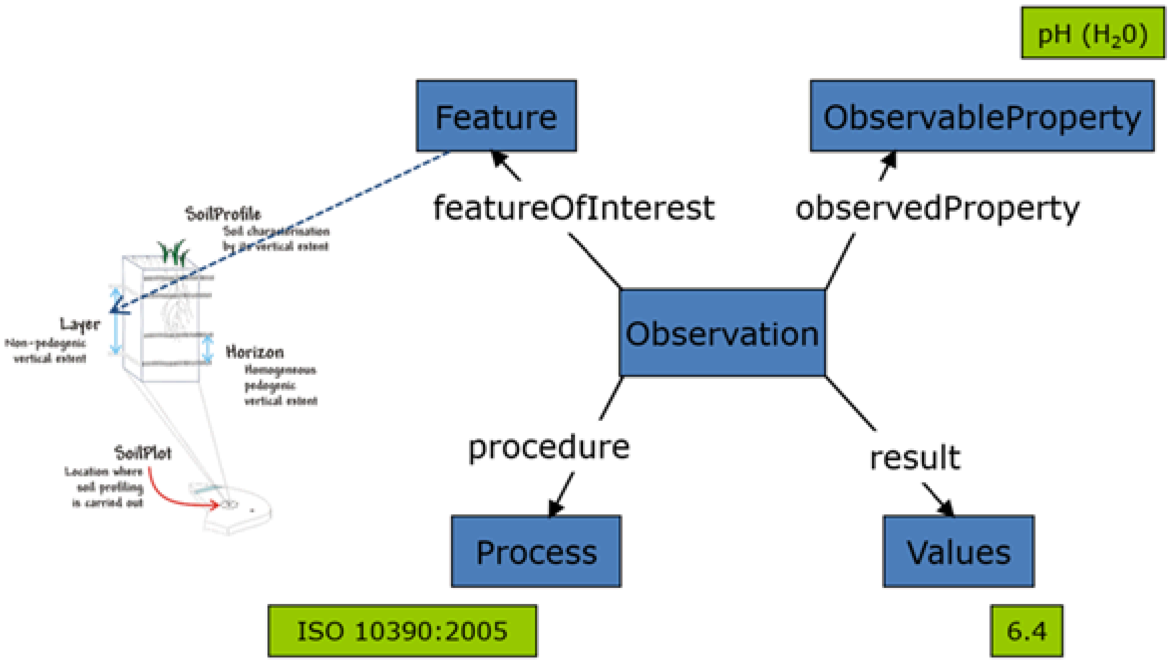


Figure 7: Observation of the pH of a Soil Layer