Deliverable **4.2**	
A refined system ontology	
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System ontology

This document describes the system ontology of HELICOPTER.

SensorML 1.1

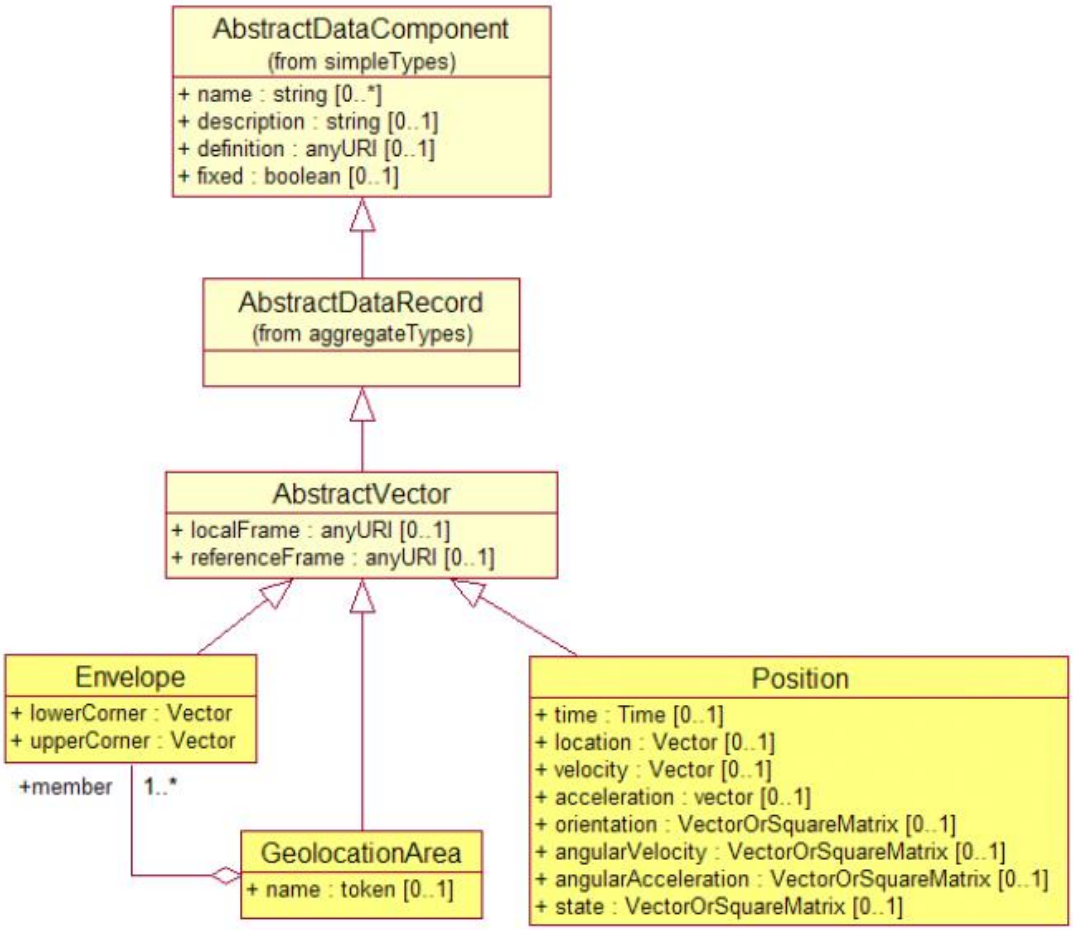
For example, in section 4 in the SensorML standard, the following excerpt exemplifies important concepts of the ontoloEssentially, HELICOPTER is based on the SensorML 1.1 standard (http://www.opengeospatial.org/standards/sensorml) and the XAPI terminology from Advanced Distributed Learning (www.adlnet.gov).
gy:

Concept	Definition	Comment
4.5 Detector	Atomic part of a composite Measurement System defining sampling and response characteristic of a simple detection device. A detector has only one input and one output, both being scalar quantities. More complex Sensors, such as a frame camera, which are composed of multiple detectors can be described as a detector group or array using a System or Sensor. In SensorML a detector is a particular type of Process Model.	In HELICOPTER domain model, we refer to sensors. Typically this means detectors.
4.6 Determinand	A Parameter or a characteristic of a phenomenon subject to observation. Synonym for observable.	In HELICOPTER, we have employed evidence indicators.
4.7 Location	A point or extent in space relative to a coordinate system. For point-based systems, this is typical expressed as a set of n-dimensional coordinates within the coordinate system. For bodies, this is typically expressed by relating the translation of the origin of an object's local coordinate system with respect to the origin of an external reference coordinate system.	In HELICOPTER, we employ GIS-based coordinates.

4.10 Measure (noun)	Value described using a numeric amount with a scale or using a scalar reference system [ISO/TS 19103]. When used as a noun, measure is a synonym for physical quantity.	
4.17 Phenomenon	A physical property that can be observed and measured, such as temperature, gravity, chemical concentration, orientation, number-of-individuals. A characteristic of one or more feature types, the value for which must be estimated by application of some procedure in an observation.	In HELICOPTER, the emphasis is on evaluation of diagnostic suspicions as well as anomalies in normal behavior. So, the phenomena that are studied are related to the well-being of the providee.
4.18 Position	The location and orientation of an object relative to a coordinate system. For body-based systems (in lieu of point-based systems) is typically expressed by relating the object's local coordinate system to an external reference coordinate system. This definition is in contrast to some definitions (e.g. ISO 19107) which equate position to location	In HELICOPTER, the position of most sensors are stable and rarely change. In some cases, the orientation is robust to changes (e.g., passive infrared sensor).
4.19 Process	A process that takes one or more inputs, and based on parameters and methodologies, generates one or more outputs.	In HELICOPTER, the process is drafted in the domain model document and has been detailed out in the submission to IEEE Test & Design as well as in deliverable D4.3.
4.23 Result	An estimate of the value of some property generated by a known procedure	In HELICOPTER, the result is the risk of diagnostic suspicion being true or that there is an anomaly potentially indicating some problem.
4.25 Sensor	An entity capable of observing a phenomenon and returning an observed value. In SensorML, modeled as a specific type of System representing a complete Sensor. This could be for example a complete airborne scanner which includes several Detectors (one for each band).	

4.30 value	Member of the value-space of a datatype. A value may use one of a variety of scales including nominal, ordinal, ratio and interval, spatial and temporal. Primitive datatypes may be combined to form aggregate datatypes with aggregate values, including vectors, tensors and images	In HELICOPTER, we employ a multitude of scales. In the reasoning, ordinal scales are employed both for input and output. For example, we translate the weight change into the ordinal scale { “normal_or_decrease”, “increasing” } to indicate the direction of the change (if any). Anomaly detection is employed to find out if there is a change and then this change is compared to the expected value to determine if the trend is increasing, decreasing or steady.

Concerning the formal aspects of the ontology, section 8 in the SensorML 1.1 is used as a basis. For example, figure 8.4 defines the position of, for example, an observation.



Discussion

The major advantage of employing existing standards is they increase the likelihood of completeness, unambiguity and precision as well as typically balancing tractability and power (expressability). The major disadvantage is that legacy parts (e.g., components, documentation) etc. has to be adapted. In HELICOPTER, we gradually move towards the standard.

The SensorML standard is developed for geographical information systems and in HELICOPTER we only need a subpart of all possibilities. For example, in contrast to a satellite where speed, acceleration, angles etc. are important, most of our sensors are immobile components whose position do not change.

Learning

In xAPI, states are expressed as verbs. For example, a person has completed something. In xAPI, there is JSON definition. An excerpt of verbs from this standard is:

Verb	Definition	JSON example
attempted	Used at the initiation of many "experienced" activities to mark the entry. Attempts without further verbs could be incomplete in some cases.	`{ "id": "http://adlnet.gov/expapi/verbs/attempted", "display": { "en-US": "attempted" } }`
progressed	A value, typically within a scale of progression, to how much of an activity has been accomplished. This is not to be confused with 'mastered', as the level of success or competency a user gained is not guaranteed by progress.	`{ "id": "http://adlnet.gov/expapi/verbs/progressed", "display": { "en-US": "progressed" } }`
responded	This verb is used to record a learner's action of responding to some action or event. Examples include responding to a fire alarm or responding to a question.	`{ "id": "http://adlnet.gov/expapi/verbs/responded", "display": { "en-US": "responded" } }`

An excerpt of relevant activities are:

Activity	Definition	JSON Example
interaction	An interaction is typically a part of a larger activity (such as a assessment, game, or simulation) and refers to a control to which a learner provides input. An interaction can be either an asset or function independently.	`"object": { "objectType": "Activity", "id": "http://www.ambulance.vic.gov.au/flash/interactive/equipment/index.htm", "definition": { "name": { "en-US": "Ambulance Equipment" }, "description": {`

		"en-US": "This interaction requires the learner to interact with equipment on an ambulance." }, "type": "http://adlnet.gov/expapi/activities/interaction", "moreInfo": "http://www.ambulance.vic.gov.au/flash/interactive/equipment/index.htm", } } }
objective	An objective determines whether competency has been achieved in a desired area. Objectives typically are associated with questions and assessments. Objectives are not learning content and cannot be SCOs.	"object": { "objectType": "Activity", "id": "http://alex.state.al.us/lesson_view.php?id=29832", "definition": { "name": { "en-US": "The Elements of the Periodic Table" }, "description": { "en-US": "Students will understand, apply, interpret and evaluate the Periodic Table of Elements." }, "type": "http://adlnet.gov/expapi/activities/objective", "moreInfo": "http://alex.state.al.us/lesson_view.php?id=29832", } } }

Discussion

In HELICOPTER, a providee that attempts something, can get an “attempted” in that situation. For example, if the providee checked that HELICOPTER worked, then they can get that marked in the system. If the providee performs a complete system test by checking some related sensors, then they could get “progressed”. If the providee is asked to provide information and they do respond, then (first time) they can get attempted and responded in their log.

In essence, as briefly outlined in the domain model D4.1, the learning of providees deals with using the HELICOPTER system as well as improving the well-being of themselves. The learning of caregivers include, but is not limited to, how to interpret and act appropriately with respect to the output from the HELICOPTER system; for example, if the HELICOPTER system indicates that there is a risk go through a check list to double check if there is a real risk. If, for example, there has been visitors visiting the providee, then the system could report anomalies and a part of the check list should then be “have there been visitors?” (or something similar).

Other parts of the ontology

The other parts of the ontology are outlined in the domain model document D4.1, where, for example, the different roles (providee, caregiver, etc.) are defined as well as diagnostic suspicions and how they are related to evidence indicators (detectors and phenomena).