

# Conceptual model for uncertainty

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A Recent trend in software engineering towards loosely coupled, service oriented, distributed systems has sparked the generation of various interoperable standards. Within the GI domain the migration from legacy systems has seen the birth of the 'Sensor Web' --- a collection of XML languages and services for describing and exchanging sensor observation data. This collection of standards ranges from the Observations & Measurements schema (O&M) for describing the act of observing to the Sensor Model Language (SensorML) used for describing the lineage of an observation. As this Sensor Web community grows, an increasing volume of data will become available and require processing, and much of this data will be used for decision support. However, rational decision making using incomplete knowledge (i.e. sensor measurements) is only possible when uncertainty in the measurements, and their subsequent processing, is quantified. This uncertainty must be represented in an interoperable manner. Currently, within the Sensor Web framework no formal method of quantifying complex uncertainties (e.g. probabilistic representations) exists. We provide a conceptual model, entitled 'UncertML', as a solution to the problem.

UncertML is an XML schema for describing uncertain information, for example, in online risk management chains. UncertML is capable of describing a range of uncertainties: from summaries, such as simple statistics (e.g. the mean and variance of an observation), to more complex representations such as parametric distributions at each point of a regular grid, perhaps generated by some geostatistical interpolation process. We demonstrate the integration of UncertML into several aspects of the Sensor Web from describing the observation error within an O&M document to providing a series of exceedance probabilities generated by an interpolation of sensor observations. The INTAMAP (INTERoperability and Automated MAPping) project offers a use case for UncertML and demonstrates a direct need for such a standard.

This conceptual model of uncertainty delegates a selection of GI data to other supporting standards. Phenomena, their units of measure and geo-spatial attributes are two such examples. Removing the constraints of such properties allows UncertML to remain as a set of simple data types that can be integrated into a wider range of subject domains.