HSML Schema

HSML & the Spatial Web

The **Spatial Web** standard aims to set the guidelines that will define the Web 3.0, a computing environment that will blur the lines between the physical and digital worlds. The Spatial Web is an evolution of the internet, where we move from a 2D environment to a 3D virtual space that will allow people to interact with places, things, and each other (René & Mapes, 2019). To be able to place information spatially and contextually, we require a detailed map that explains how all the different data is related to each other in the system. This is where the **Hyperspace Modeling Language (HSML)** comes into play. HSML is a multi-dimensional ontology for encoding fundamental elements and the relationships between them (IEEE Computer Society, 2024). HSML does for the Spatial Web as HTML does for the WWW.

HSML Ontology Hierarchy

This ontology is composed of different types of elements, also known as **classes**. The highest class in the hierarchy is **Entity.** Entities are the base items used across the Spatial Web in HSML, and all the other classes are subtypes of the Entity base class. These include, but are not limited to, **Activity**, **Agent**, **Contract**, **Channel**, **Credential**, **Domain**, **Hyperspace/Space**, and **Time** (IEEE Computer Society, 2024). These classes allow to mark and identify the different elements that encompass both our physical and virtual reality, their meaning and relations are represented more clearly in **Figure 1**.

The Spatial Web classes hierarchy is as follows:

- **ENTITY:** that which is perceived, known, or inferred to exist, has existed, or is anticipated to exist. Entity is the base item in the Spatial Web Ontology.
  - **ACTIVITY:** A single action or partially ordered set of actions performed by an Agent. An Activity is a specific instance of an Activity Schema that is planned or executed by an Agent. An Activity may be planned, ongoing, failed, or completed. An Activity is performed on, by, in, or with, Domains, including other Agents. An Activity is a process that can be near-instantaneous or temporally extended. Attributes of an Activity can be represented using Hyperspace Entities.
  - **CHANNEL:** A stream of HSML Entities that are related to an Activity of a specific context that does not itself warrant a Domain or hierarchy. A Channel contains HSML messages that relate to an HSML Activity. A CHANNEL may be a collection of CHANNELs, where the wider CHANNEL will contain all information from all lower CHANNELs. CHANNEL be specific to a specific ACTIVITY or ACTIVITIES. CHANNEL be specific to a specific AGENTS based on CREDENTIALS
  - **CONTRACT:** A binding agreement between two parties, especially enforceable by law, or a similar internal agreement wholly within an organization.

- o **CREDENTIAL:** A set of one or more claims made by a Domain. Examples of claims include identity of a Domain, membership in a Domain, ability of a Domain to perform an Activity.
- o **DOMAIN:** Sphere of knowledge, influence, or Activity. A Domain retains its identity over time even though its states and relations may change. There are different Domain types,
    - ▪ **AGENT:** individual domains with active states and agency. An Entity that senses, responds, and maintains a model of its environment, while performing actions to achieve its goals.
    - ▪ **Geographic:** implicitly or explicitly associated with a location
    - ▪ **Concept:** intangible concepts and abstract ideas shared by a community of users
    - ▪ **Organization:** Pertaining to membership within an entity
    - ▪ **Person:** special subtype of agent maintaining a self-sovereign identity
    - ▪ **Thing:** bounded items without agency
- o **HYPERSPACE/SPACE:** A set of 'points' such that, for every ordered pair of points, there is a possibly empty set of 'paths' from the first point to the second, and such that there is an 'identity' path from every point to itself.
- o **TIME:** may be a dimension in spacetime, a length of a duration, a trajectory, related to a clock. When experienced by an Agent, Time has a past, present, and future. Time is related to Hyperspace or to Activities.

Additionally, a **domain authority** is an ENTITY that is CREDENTIALED to have the ability to define within a DOMAIN the norms and terms under which CONTRACTS are created governing: actors, actions and CREDENTIALS within that DOMAIN.
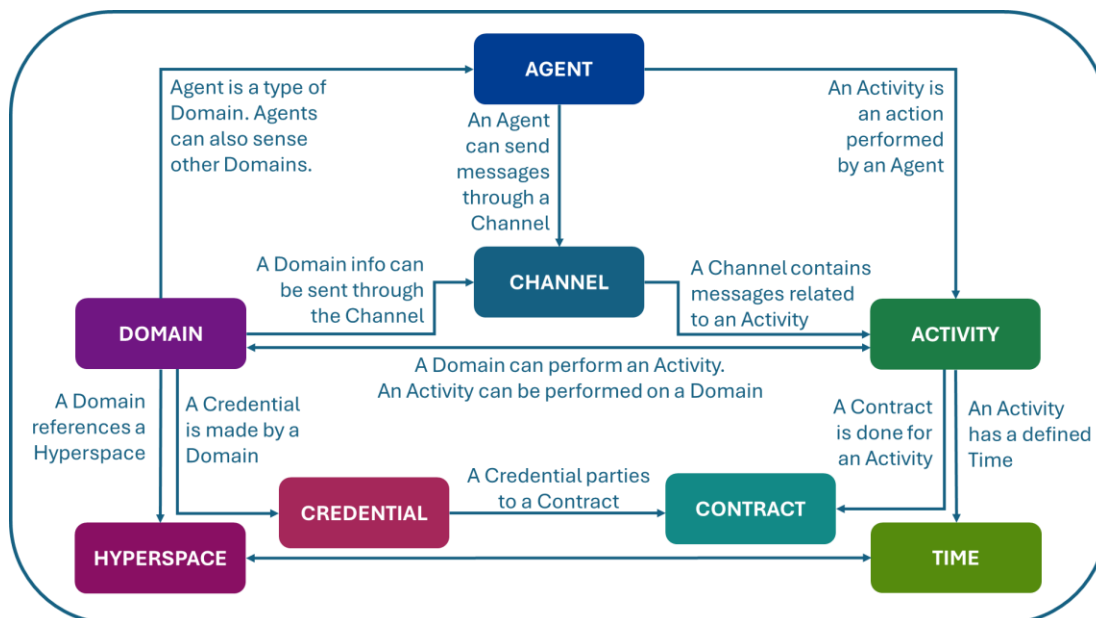

Figure 1. Map of the Entity subtypes that conform the HSML ontology.

HSML Schema

HSML encodes these Entities in a format, e.g. JSON (IEEE Computer Society, 2024). The JSON file organizes the information in a way that follows the rules and definitions set by the HSML schema. The JSON file of each Entity created must include the context (link to hsml.jsonld schema file), a unique identifier, name, description, type (either Entity or one of the other classes in the Spatial Web ontology), links to other Entities, and properties. An example of what a simple JSON file using our schema would look like is shown in **Figure 2**. By exchanging these text files that encode the information in the same format, the data can be read and used across different platforms.

```json
{
  "@context": "https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld",
  "@type": "Entity",
  "name": "Example Entity",
  "description": "This is an example entity type.",
  "swid": "did:key:6MkvWxmpULqn65HWJ7id7GF2G8CGWeGs9GvftPw3ZPESuLC"
}
```

Figure 2. Entity JSON file Example using HSML Schema.

To register the identity of any user, space, or asset on the Spatial Web, we need a globally unique "decentralized identifier" (DID) based on W3C Standards (René & Mapes, 2019). The unique identifier receives the name of **SWID** (Spatial Web Identifier). However, no SWID method exists yet, so for now a DID key method can be used to implement the HSML schema.

Schema.org is a collaborative website that provides a collection of shared vocabularies for marking up web content, which big companies like Google follow. Making our HSML schema compatible with Schema.org offers a variety of benefits. Among them, it facilitates the adoption by future users, who are already used to Schema.org's structure, and it allows us to save time by drawing from existing types and properties. **Figure 3** shows the HSML Classes defined in the HSML schema context and the correspondent Schema.org types, from which each HSML class can draw existing relevant properties.
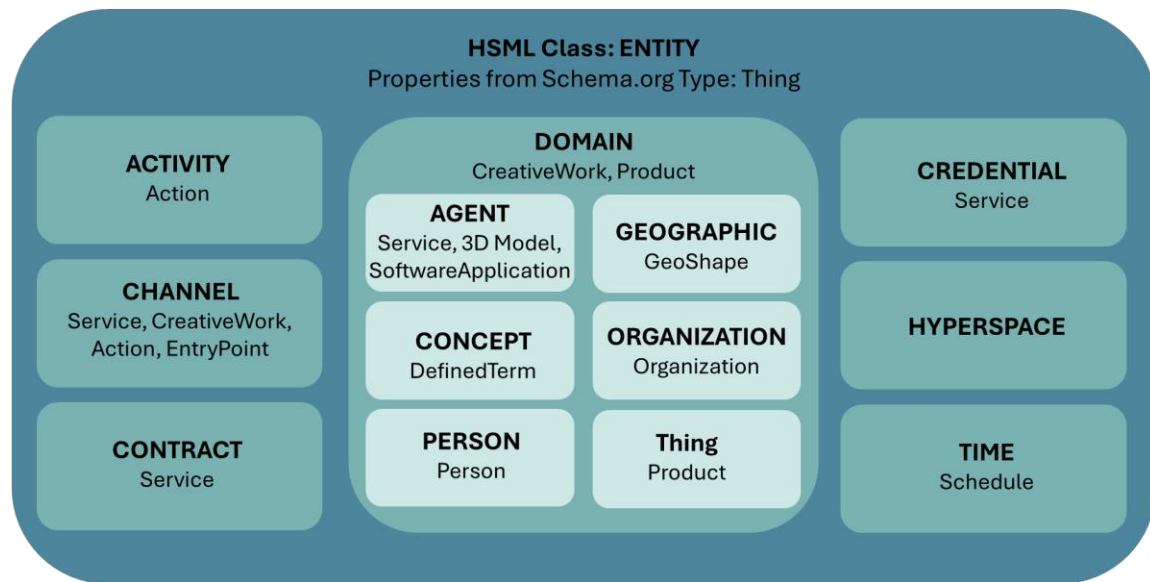
Figure 3. HSML Ontology Classes Hierarchy and their correspondent Schema.org Types, from which they draw some properties inside the HSML Schema.

Why is HSML Important for Us

There are three main reasons why we need to consider HSML in the context of Digital Twins interoperability:

1. We need consistency in order to achieve interoperability between digital twins. And to interact, we must speak the same language, which is HSML.
2. The Spatial Web describes a future in which we change from a 2D to a 3D view, in a both spatial and contextual approach. Thinking about the context, this is the connections with all the other elements, is also of paramount importance to Digital Twins. As we must not only define the digital twins' 3D models but also the space they occupy, who they belong to and who has access to them and give them a unique identifier that allows them to be exchanged safely.
3. Also, one of the key features of the Spatial Web standard and HSML, is the consideration of safety and trustworthiness through its Credentials, Contracts, and Decentralized Identifiers. This regard for a safe exchange of assets is one of the things that make HSML so unique.

HSML Schema Use Case:

To better showcase how this HSML schema comes into play, this use case shows the Entities involved when two digital twins interact with each other. **Figure 4** displays the relationship between all the elements of the example.

- Two **Organizations**, Company A and Company B, sign a **Contract** to work together on a space mission to the Moon.

- The Rover of Comp. A will be carried inside the Lander of Comp. B. (**Agents**)

- Once they reach the Moon, the Rover will leave the Lander. To make sure this **Activity** is developed without any problem, Comp. B needs to work with the model of the Lunar Rover and run some simulations.

- A **Credential** is issued by Comp. A, authorizing Comp. B users (**Person**) to have access to the 3D Model of their rover for a Period of 3 Months (**Time**).

- The model of the Lunar Rover is in Unreal, and the model of the Lander is in Omniverse; both have a Moon surface environment modelled. The **Hyperspace** must consider, the location (the Moon), and the appropriate coordinate systems and transforms needed to go from one platform to the other.

- All the messages and communications related to this Activity are carried out in a **Channel**.

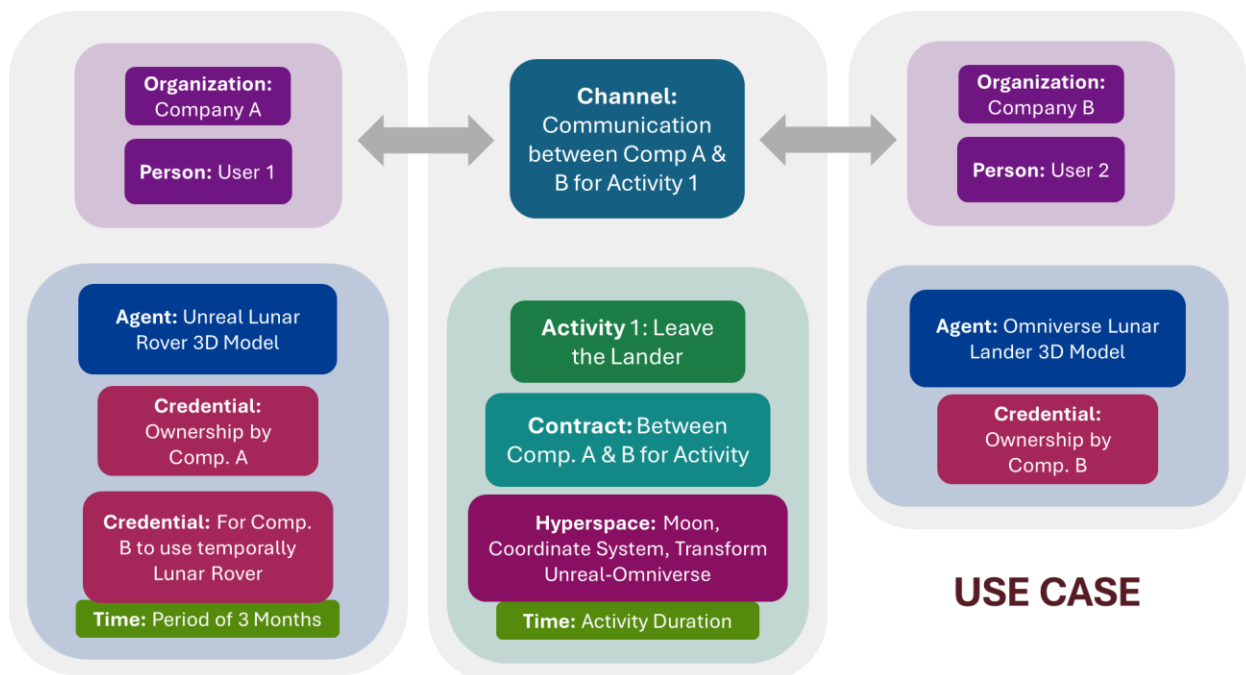
Figure 4. Use Case of HSML Schema. The diagram displays all the Entities mentioned in the Use Case and how they are related to one another to show the interaction between all the classes inside the HSML Schema in a possible real-life example.

HSML Schema.org Types to draw properties from

For each of the HSML classes the equivalent existing Schema.org types were found to draw properties from them. Some of them have more than one option depending on the exact nature of what we are trying to represent. However, some of the properties needed to represent these entities do not exist in Schema.org, so we will also need to create our own.

- **ENTITY** – **schema:Thing**
  - **ACTIVITY** – **schema:Action** or **schema:Event** (defined time and place)
  - **CONTRACT** – does not seem to be defined exactly like we would want it, There is **schema:Offer** (for proposed agreements or offers in a transactional context, transfer rights to an object), but it doesn't inherently include properties for tracking contract statuses like "Requested," "Executed," etc; or also **schema:Service** may be another option, but also lacks some fields.
  - **CHANNEL** – does not seem to be defined in schema, the closest matches are schema:ServiceChannel or schema:BroadcastChannel. We could create our own, although this file would just define the Kafka topics used by the users to communicate with each other. These channels/topics would especially be destined to exchange credentials, contracts, determine the duration of these, etc; not directly for access to the different Agents.
  - **CREDENTIAL** – **schema:Permit** (for licenses or permissions granted by an authority), but lacks properties like the credential category, the usage restriction, and the permit extension which may be interesting to add.
  - **DOMAIN** – it depends on the type:
    - **AGENT** – **schema:3DModel** or **schema:SoftwareApplication.** Note: Goal cannot be defined in the properties though.
    - **Geographic** – **schema:GeoShape** or **schema:Landform**
    - **Concept** – **schema:DefinedTerm**
    - **Organization** – **schema:Organization**
    - **Person** – **schema:Person**
    - **Thing** – **schema:Thing**, **schema:Product** or another, it depends on the object
  - **HYPERSPACE/SPACE** – schema:Place (for physical places) or schema:SoftwareApplication (for virtual spaces). None of them account for the association to a Domain. For this class, it is more beneficial to create our own and build on it.
  - **TIME** – **schema:Duration** (for periods of time), **schema:DateTime** (for specific timestamps), or **schema:Schedule** (for repeating or planned temporal events). Note: Time itself is a data type in schema.

Entity

An HSML Class

Entity

The base item in the Spatial Web Ontology.

Property	Expected Type	Description
Properties from **Thing**		
additionalType	Text or URL	An additional type for the item, typically used for adding more specific types from external vocabularies in microdata syntax. This is a relationship between something and a class that the thing is in. Typically the value is a URI-identified RDF class, and in this case corresponds to the use of rdf:type in RDF. Text values can be used sparingly, for cases where useful information can be added without their being an appropriate schema to reference. In the case of text values, the class label should follow the schema.org style guide.
alternateName	Text	An alias for the item.
description	Text or TextObject	A description of the item.
disambiguatingDescription	Text	A sub property of description. A short description of the item used to disambiguate from other, similar items. Information from other properties (in particular, name) may be necessary for the description to be useful for disambiguation.
identifier	PropertyValue or Text or URL	The identifier property represents any kind of identifier for any kind of Thing, such as ISBNs, GTIN codes, UUIDs etc. Schema.org provides dedicated properties for representing many of these, either as textual strings or as URL (URI) links. See background notes for more details.
image	ImageObject or URL	An image of the item. This can be a URL or a fully described ImageObject.
mainEntityOfPage	CreativeWork or URL	Indicates a page (or other CreativeWork) for which this thing is the main entity being described. See background notes for details. Inverse property: mainEntity
name	Text	The name of the item.
potentialAction	Action	Indicates a potential Action, which describes an idealized action in which this thing would play an 'object' role.

sameAs	URL	URL of a reference Web page that unambiguously indicates the item's identity. E.g. the URL of the item's Wikipedia page, Wikidata entry, or official website.
subjectOf	CreativeWork or Event	A CreativeWork or Event about this Thing. Inverse property: about
url	URL	URL of the item.
Custom Properties for **Entity**		
linkedTo	Entity	The schema of other entities to which this entity is connected.
swid	URL	A unique identifier for objects in the Spatial Web. Currently, a DID:key generated for each Entity.

Activity

An HSML Class

Entity > **Activity**

A single action or partially ordered set of actions performed by an Agent. An Activity is a specific instance of an Activity Schema that is planned or executed by an Agent. An Activity may be planned, ongoing, failed, or completed. An Activity is performed on, by, in, or with, Domains, including other Agents. An Activity is a process that can be near-instantaneous or temporally extended. Attributes of an Activity can be represented using Hyperspace Entities.

Property	Expected Type	Description
Properties from **Action**		
actionProcess	HowTo	Description of the process by which the action was performed.
endTime	DateTime or Time	The endTime of something. For a reserved event or service (e.g. FoodEstablishmentReservation), the time that it is expected to end. For actions that span a period of time, when the action was performed. E.g. John wrote a book from January to December. For media, including audio and video, it's the time offset of the end of a clip within a larger file. Note that Event uses startDate/endDate instead of startTime/endTime, even when describing dates with times. This situation may be clarified in future revisions.
error	Thing	For failed actions, more information on the cause of the failure.
instrument	Thing	The object that helped the agent perform the action. E.g. John wrote a book with a pen.
location	Place or PostalAddress or Text or VirtualLocation	The location of, for example, where an event is happening, where an organization is located, or where an action takes place.
object	Thing	The object upon which the action is carried out, whose state is kept intact or changed. Also known as the semantic roles patient, affected or undergoer (which change their state) or theme (which doesn't). E.g. John read a book.
participant	Organization or Person	Other co-agents that participated in the action indirectly. E.g. John wrote a book with Steve.

provider	Organization or Person	The service provider, service operator, or service performer; the goods producer. Another party (a seller) may offer those services or goods on behalf of the provider. A provider may also serve as the seller. Supersedes carrier.
result	Thing	The result produced in the action. E.g. John wrote a book.
startTime	DateTime or Time	The startTime of something. For a reserved event or service (e.g. FoodEstablishmentReservation), the time that it is expected to start. For actions that span a period of time, when the action was performed. E.g. John wrote a book from January to December. For media, including audio and video, it's the time offset of the start of a clip within a larger file. Note that Event uses startDate/endDate instead of startTime/endTime, even when describing dates with times. This situation may be clarified in future revisions.
target	EntryPoint or URL	Indicates a target EntryPoint, or url, for an Action.
Custom Properties for **Activity**		
activityHasInstance	Activity	Used to indicate smaller activities that are instances of the current activity.
activityIsInstanceOf	Activity	Used to indicate a greater activity of which this activity is an instance of.
activityStatus	Text	Indicates the current status or disposition of the activity. For example, planned, in progress, completed or failed.
actor	Agent or Person or Organization	The direct performer or driver of the action (animate or inanimate).
collaborator	Domain	The domain (usually an Agent) with whose help this activity is performed.
condition	Text	It can be an initial condition (defined using variables), intermediate conditions or end conditions that define the activity.
goal	Text	The desired state or outcome of the Activity.
hasContract	Contract	The contract under which the activity is performed.
monitoredBy	Organization or Person	Organization or person in charge of monitoring and overseeing the Activity.
openVariables	Text	Variables that define the activity performed.
performedOn	Agent or Geographic or Thing	The domain (whether geographic, a thing or an agent) on or in which the activity is performed.

Channel

An HSML Class

Entity > **Channel**

A Channel contains HSML messages that relate to an HSML Activity.

Property	Expected Type	Description
Properties from **Service**		
areaServed	AdministrativeArea or GeoShape or Place or Text	The geographic area where a service or offered item is provided. Supersedes serviceArea.
audience	Audience	An intended audience, i.e. a group for whom something was created. Supersedes serviceAudience.
availableChannel	ServiceChannel	A means of accessing the service (e.g. a phone bank, a web site, a location, etc.).
provider	Organization or Person	The service provider, service operator, or service performer; the goods producer. Another party (a seller) may offer those services or goods on behalf of the provider. A provider may also serve as the seller. Supersedes carrier.
Properties from **CreativeWork**		
about	Thing	The subject matter of the content. Inverse property: subjectOf
creator	Organization or Person	The creator/author of this CreativeWork. This is the same as the Author property for CreativeWork.
hasPart	CreativeWork	Indicates an item or CreativeWork that is part of this item, or CreativeWork (in some sense). Inverse property: isPartOf
inLanguage	Language or Text	The language of the content or performance or used in an action. Please use one of the language codes from the IETF BCP 47 standard. See also availableLanguage. Supersedes language.
isPartOf	CreativeWork or URL	Indicates an item or CreativeWork that this item, or CreativeWork (in some sense), is part of. Inverse property: hasPart

	Thing	Indicates the primary entity described in some page or other CreativeWork. Inverse property: mainEntityOfPage
mainEntity		
Properties from **Action**		
location	Place or PostalAddress or Text or VirtualLocation	The location of, for example, where an event is happening, where an organization is located, or where an action takes place.
Properties from **EntryPoint**		
contentType	Text	The type of content that can be shared through the channel (e.g., data stream, video, messages).
Custom Properties for **Channel**		
access	Entity	The list of entities (e.g., agents, organizations) who have access to the channel
channelStatus	Text	The current status of the channel (e.g, active, inactive).
durationChannel	Time	The duration for which the channel is active or available.
messageCount	Number	The total number of messages sent inside the Channel.
parentChannel	Channel	Indicates if the channel is a sub-channel of another channel.
relatedActivity	Activity	The activity or activities that the channel is related to.
streamData	Text or URL	The real-time or recorded data associated with a Channel, capturing information about Activities, Credentials, messages, interactions, or shared content over time.

Contract

An HSML Class

Entity > **Contract**

A binding agreement between two parties, especially enforceable by law, or a similar internal agreement wholly within an organization.

Property	Expected Type	Description
Properties from **Service**		
areaServed	AdministrativeArea or GeoShape or Place or Text	The geographic area where a service or offered item is provided. Supersedes serviceArea.
audience	Audience	An intended audience, i.e. a group for whom something was created. Supersedes serviceAudience.
category	CategoryCode or PhysicalActivityCategory or Text or Thing or URL	A category for the item. Greater signs or slashes can be used to informally indicate a category hierarchy.
isRelatedTo	Product or Service	A pointer to another, somehow related product (or multiple products).
offers	Demand or Offer	An offer to provide this item—for example, an offer to sell a product, rent the DVD of a movie, perform a service, or give away tickets to an event. Use businessFunction to indicate the kind of transaction offered, i.e. sell, lease, etc. This property can also be used to describe a Demand. While this property is listed as expected on a number of common types, it can be used in others. In that case, using a second type, such as Product or a subtype of Product, can clarify the nature of the offer. Inverse property: itemOffered
provider	Organization or Person	The service provider, service operator, or service performer; the goods producer. Another party (a seller) may offer those services or goods on behalf of the provider. A provider may also serve as the seller. Supersedes carrier.

serviceOutput	Thing	The tangible thing generated by the service, e.g. a passport, permit, etc. Supersedes produces.
serviceType	GovernmentBenefitsType or Text	The type of service being offered, e.g. veterans' benefits, emergency relief, etc.
termsOfService	Text or URL	Human-readable terms of service documentation.
Custom Properties for **Contract**		
agreement	Text	Description of the contract, describing the clauses and conditions between the signing parties.
contractStatus	Text	For tracking contract statuses like Requested, Executed, etc.
forActivity	Activity	The activity for which this contract was written.
signedBy	Organization or Person	Parties involved in the Contract.
transferRightsTo	Agent or Geographic or Thing	If the contract involves the transfer of rights for a particular agent, geographic domain, or another kind of object.

Credential

An HSML Class

Entity > **Credential**

A set of one or more claims made by a Domain. Examples of claims include identity of a Domain, membership in a Domain, or ability of a Domain to perform an Activity.

Property	Expected Type	Description
Properties from **Permit**		
issuedBy	Organization or Person	The organization issuing the item, for example a Permit, Ticket, or Certification.
issuedThrough	Service	The service through which the permit was granted.
permitAudience	Audience	The target audience for this permit.
validFor	Duration	The duration of validity of a permit or similar thing.
validFrom	Date or DateTime	The date when the item becomes valid.
validIn	AdministrativeArea	The geographic area where the item is valid. Applies for example to a Permit, a Certification, or an EducationalOccupationalCredential.
validUntil	Date	The date when the item is no longer valid.
Custom Properties for **Credential**		
accessAuthorization	Domain or Person or Organization	Identifies the person, organization, or domain that is authorized to access a specific domain, system, or resource.
accessGrant	Boolean or Text	Indicates whether access has been granted (true/false) or describes the access status (e.g., Pending, Approved).
accessLevel	Text	Describes the level or scope of access granted (e.g., Read-only, Admin, Full Control).
authorizedForDomain	Agent or Geographic or Thing	Specifies the agent, system, or environment for which the Person or Organization is authorized. For example, to a lunar surface model, a rover, or a camera.

	Text	The category or type of the credential (e.g., License, Certificate, Degree).
credentialCategory		
usageRestriction	Text	Describes any restrictions on how or where the credential can be used (e.g., Valid only in the EU).

Domain

An HSML Class

Entity > **Domain**

A sphere of knowledge, influence, or Activity. A Domain retains its identity over time even though its states and relations may change. There are different Domain types, like Agent or Person.

Property	Expected Type	Description
Properties from **CreativeWork**		
about	Thing	The subject matter of the content. Inverse property: subjectOf
abstract	Text	An abstract is a short description that summarizes a CreativeWork.
accountablePerson	Person	Specifies the Person that is legally accountable for the CreativeWork.
archivedAt	URL or Webpage	Indicates a page or other link involved in archival of a CreativeWork. In the case of MediaReview, the items in a MediaReviewItem may often become inaccessible, but be archived by archival, journalistic, activist, or law enforcement organizations. In such cases, the referenced page may not directly publish the content.
associatedMedia	MediaObject	A media object that encodes this CreativeWork. This property is a synonym for encoding.
audience	Audience	An intended audience, i.e. a group for whom something was created. Supersedes serviceAudience.
author	Organization or Person	The author of this content or rating. Please note that author is special in that HTML 5 provides a special mechanism for indicating authorship via the rel tag. That is equivalent to this and may be used interchangeably.
comment	Comment	Comments, typically from users.
conditionsOfAccess	Text	Conditions that affect the availability of, or method(s) of access to, an item. Typically used for real world items such as an ArchiveComponent held by an ArchiveOrganization. This property is not suitable for use as a general Web access control mechanism. It is expressed only in natural language. For example "Available by appointment from the Reading Room" or "Accessible only from logged-in accounts ".

contentLocation	Place	The location depicted or described in the content. For example, the location in a photograph or painting.
contentReferenceTime	DateTime	The specific time described by a creative work, for works (e.g. articles, video objects etc.) that emphasise a particular moment within an Event.
contributor	Organization or Person	A secondary contributor to the CreativeWork or Event.
copyrightHolder	Organization or Person	The party holding the legal copyright to the CreativeWork.
copyrightNotice	Text	Text of a notice appropriate for describing the copyright aspects of this Creative Work, ideally indicating the owner of the copyright for the Work.
copyrightYear	Number	The year during which the claimed copyright for the CreativeWork was first asserted.
correction	CorrectionComment or Text or URL	Indicates a correction to a CreativeWork, either via a CorrectionComment, textually or in another document.
countryOfOrigin	Country	The country of origin of something, including products as well as creative works such as movie and TV content. In the case of TV and movie, this would be the country of the principle offices of the production company or individual responsible for the movie. For other kinds of CreativeWork it is difficult to provide fully general guidance, and properties such as contentLocation and locationCreated may be more applicable. In the case of products, the country of origin of the product. The exact interpretation of this may vary by context and product type, and cannot be fully enumerated here.
creator	Organization or Person	The creator/author of this CreativeWork. This is the same as the Author property for CreativeWork.
creditText	Text	Text that can be used to credit person(s) and/or organization(s) associated with a published Creative Work.
dateCreated	Date or DateTime	The date on which the CreativeWork was created or the item was added to a DataFeed.
dateModified	Date or DateTime	The date on which the CreativeWork was most recently modified or when the item's entry was modified within a DataFeed.

datePublished	Date or DateTime	Date of first publication or broadcast. For example the date a CreativeWork was broadcast or a Certification was issued.
digitalSourceType	IPTCDigitalSourceEnumeration	Indicates an IPTCDigitalSourceEnumeration code indicating the nature of the digital source(s) for some CreativeWork.
editor	Person	Specifies the Person who edited the CreativeWork.
encoding	MediaObject	A media object that encodes this CreativeWork. This property is a synonym for associatedMedia. Supersedes encodings. Inverse property: encodesCreativeWork
encodingFormat	Text or URL	Media type typically expressed using a MIME format (see IANA site and MDN reference), e.g. application/zip for a SoftwareApplication binary, audio/mpeg for .mp3 etc. In cases where a CreativeWork has several media type representations, encoding can be used to indicate each MediaObject alongside particular encodingFormat information. Unregistered or niche encoding and file formats can be indicated instead via the most appropriate URL, e.g. defining Web page or a Wikipedia/Wikidata entry. Supersedes fileFormat.
expires	Date or DateTime	Date the content expires and is no longer useful or available. For example a VideoObject or NewsArticle whose availability or relevance is time-limited, a ClaimReview fact check whose publisher wants to indicate that it may no longer be relevant (or helpful to highlight) after some date, or a Certification the validity has expired.
funder	Organization or Person	A person or organization that supports (sponsors) something through some kind of financial contribution.
funding	Grant	A Grant that directly or indirectly provide funding or sponsorship for this item. See also ownershipFundingInfo. Inverse property: fundedItem
hasPart	CreativeWork	Indicates an item or CreativeWork that is part of this item, or CreativeWork (in some sense). Inverse property: isPartOf
inLanguage	Language or Text	The language of the content or performance or used in an action. Please use one of the language codes from the IETF BCP 47 standard. See also availableLanguage. Supersedes language.

isBasedOn	CreativeWork or Product or URL	A resource from which this work is derived or from which it is a modification or adaptation. Supersedes isBasedOnUrl.
isPartOf	CreativeWork or URL	Indicates an item or CreativeWork that this item, or CreativeWork (in some sense), is part of.Inverse property: hasPart
keywords	DefinedTerm or Text or URL	Keywords or tags used to describe some item. Multiple textual entries in a keywords list are typically delimited by commas, or by repeating the property.
license	CreativeWork or URL	A license document that applies to this content, typically indicated by URL.
locationCreated	Place	The location where the CreativeWork was created, which may not be the same as the location depicted in the CreativeWork.
mainEntity	Thing	Indicates the primary entity described in some page or other CreativeWork. Inverse property: mainEntityOfPage
maintainer	Organization or Person	A maintainer of a Dataset, software package (SoftwareApplication), or other Project. A maintainer is a Person or Organization that manages contributions to, and/or publication of, some (typically complex) artifact. It is common for distributions of software and data to be based on "upstream" sources. When maintainer is applied to a specific version of something e.g. a particular version or packaging of a Dataset, it is always possible that the upstream source has a different maintainer. The isBasedOn property can be used to indicate such relationships between datasets to make the different maintenance roles clear. Similarly in the case of software, a package may have dedicated maintainers working on integration into software distributions such as Ubuntu, as well as upstream maintainers of the underlying work.
material	Product or Text or URL	A material that something is made from, e.g. leather, wool, cotton, paper.
materialExtent	QuantitativeValue or Text	The quantity of the materials being described or an expression of the physical space they occupy.

offers	Demand or Offer	An offer to provide this item—for example, an offer to sell a product, rent the DVD of a movie, perform a service, or give away tickets to an event. Use businessFunction to indicate the kind of transaction offered, i.e. sell, lease, etc. This property can also be used to describe a Demand. While this property is listed as expected on a number of common types, it can be used in others. In that case, using a second type, such as Product or a subtype of Product, can clarify the nature of the offer. Inverse property: itemOffered
position	Integer or Text	The position of an item in a series or sequence of items.
producer	Organization or Person	The person or organization who produced the work (e.g. music album, movie, TV/radio series etc.).
provider	Organization or Person	The service provider, service operator, or service performer; the goods producer. Another party (a seller) may offer those services or goods on behalf of the provider. A provider may also serve as the seller. Supersedes carrier.
publisher	Organization or Person	The publisher of the creative work.
recordedAt	Event	The Event where the CreativeWork was recorded. The CreativeWork may capture all or part of the event. Inverse property: recordedIn
releasedEvent	PublicationEvent	The place and time the release was issued, expressed as a PublicationEvent.
schemaVersion	Text or URL	Indicates (by URL or string) a particular version of a schema used in some CreativeWork. This property was created primarily to indicate the use of a specific schema.org release, e.g. 10.0 as a simple string, or more explicitly via URL, https://schema.org/docs/releases.html#v10.0. There may be situations in which other schemas might usefully be referenced this way, e.g. http://dublincore.org/specifications/dublin-core/dces/1999-07-02/ but this has not been carefully explored in the community.
sdDatePublished	Date	Indicates the date on which the current structured data was generated / published. Typically used alongside sdPublisher.
sdLicense	CreativeWork or URL	A license document that applies to this structured data, typically indicated by URL.

sdPublisher	Organization or Person	Indicates the party responsible for generating and publishing the current structured data markup, typically in cases where the structured data is derived automatically from existing published content but published on a different site. For example, student projects and open data initiatives often re-publish existing content with more explicitly structured metadata. The sdPublisher property helps make such practices more explicit.
size	DefinedTerm or QuantitativeValue or SizeSpecification or Text	A standardized size of a product or creative work, specified either through a simple textual string (for example 'XL', '32Wx34L'), a QuantitativeValue with a unitCode, or a comprehensive and structured SizeSpecification; in other cases, the width, height, depth and weight properties may be more applicable.
sourceOrganizatio n	Organization	The Organization on whose behalf the creator was working.
spatial	Place	The "spatial" property can be used in cases when more specific properties (e.g. locationCreated, spatialCoverage, contentLocatio n) are not known to be appropriate.
spatialCoverage	Place	The spatialCoverage of a CreativeWork indicates the place(s) which are the focus of the content. It is a subproperty of contentLocation intended primarily for more technical and detailed materials. For example with a Dataset, it indicates areas that the dataset describes: a dataset of New York weather would have spatialCoverage which was the place: the state of New York.
sponsor	Organization or Person	A person or organization that supports a thing through a pledge, promise, or financial contribution. E.g. a sponsor of a Medical Study or a corporate sponsor of an event.
temporal	DateTime or Text	The "temporal" property can be used in cases where more specific properties (e.g. temporalCoverage, dateCreated, dateModified, d atePublished) are not known to be appropriate.

temporalCoverage	DateTime or Text or URL	The temporalCoverage of a CreativeWork indicates the period that the content applies to, i.e. that it describes, either as a DateTime or as a textual string indicating a time period in ISO 8601 time interval format. In the case of a Dataset it will typically indicate the relevant time period in a precise notation (e.g. for a 2011 census dataset, the year 2011 would be written "2011/2012"). Other forms of content, e.g. ScholarlyArticle, Book, TVSeries or TVEpisode, may indicate their temporalCoverage in broader terms - textually or via well-known URL. Written works such as books may sometimes have precise temporal coverage too, e.g. a work set in 1939 - 1945 can be indicated in ISO 8601 interval format format via "1939/1945". Open-ended date ranges can be written with ".." in place of the end date. For example, "2015-11/.." indicates a range beginning in November 2015 and with no specified final date. This is tentative and might be updated in future when ISO 8601 is officially updated. Supersedes datasetTimeInterval.
text	Text	The textual content of this CreativeWork.
timeRequired	Duration	Approximate or typical time it usually takes to work with or through the content of this work for the typical or target audience.
usageInfo	CreativeWork or URL	The schema.org usageInfo property indicates further information about a CreativeWork. This property is applicable both to works that are freely available and to those that require payment or other transactions. It can reference additional information, e.g. community expectations on preferred linking and citation conventions, as well as purchasing details. For something that can be commercially licensed, usageInfo can provide detailed, resource-specific information about licensing options. This property can be used alongside the license property which indicates license(s) applicable to some piece of content. The usageInfo property can provide information about other licensing options, e.g. acquiring commercial usage rights for an image that is also available under non-commercial creative commons licenses.
version	Number or Text	The version of the CreativeWork embodied by a specified resource.

video	Clip or VideoObject	An embedded video object.
Properties from Product		
additionalProperty	PropertyValue	A property-value pair representing an additional characteristic of the entity, e.g. a product feature or another characteristic for which there is no matching property in schema.org. Note: Publishers should be aware that applications designed to use specific schema.org properties (e.g. https://schema.org/width, https://schema.org/color, https://schema.org/gtin13, ...) will typically expect such data to be provided using those properties, rather than using the generic property/value mechanism.
Custom Properties for Domain		
canAccess	Organization or Person	Specifies the organization(s) or person(s) that are authorized to access this domain.
coordinateSystem	Text	Specifies the type of coordinate system used in the domain (e.g., Cartesian, Spherical, Geodetic).
requiresCredential	Credential	Indicates the credential required to access or interact with this domain.
platform	Text or URL	The name or identifier of the software platform or system to which the item belongs (e.g., Omniverse, Unreal, Unity).
spaceLocation	Hyperspace	The space or environment where the domain exists or operates (e.g., Moon, Earth, Mars Orbit).
specification	Text	Describes the specifications, standards, or rules that define this domain.
volume	PropertyValue	The measure of the volume of an entity defined by its length, width and height dimensions.

Agent

An HSML Class

Entity > **Domain** > **Agent**

An individual domain with active states and agency. An Agent is an Entity that senses, responds, and maintains a model of its environment, while performing actions to achieve its goals.

Property	Expected Type	Description
Properties from 3**DModel**		
isResizable	Boolean	Whether the 3DModel allows resizing. For example, room layout applications often do not allow 3DModel elements to be resized to reflect reality.
Properties from **MediaObject**		
associatedArticle	NewsArticle	A NewsArticle associated with the Media Object.
bitrate	Text	The bitrate of the media object.
contentSize	Text	File size in (mega/kilo)bytes.
contentUrl	URL	Actual bytes of the media object, for example the image file or video file.
duration	Duration	The duration of the item (movie, audio recording, event, etc.) in ISO 8601 duration format.
embedUrl	URL	A URL pointing to a player for a specific video. In general, this is the information in the src element of an embed tag and should not be the same as the content of the loc tag.
encodingFormat	Text or URL	Media type typically expressed using a MIME format (see IANA site and MDN reference), e.g. application/zip for a SoftwareApplication binary, audio/mpeg for .mp3 etc. In cases where a CreativeWork has several media type representations, encoding can be used to indicate each MediaObject alongside particular encodingFormat information. Unregistered or niche encoding and file formats can be indicated instead via the most appropriate URL, e.g. defining Web page or a Wikipedia/Wikidata entry. Supersedes fileFormat.

endTime	DateTime or Time	The endTime of something. For a reserved event or service (e.g. FoodEstablishmentReservation), the time that it is expected to end. For actions that span a period of time, when the action was performed. E.g. John wrote a book from January to December. For media, including audio and video, it's the time offset of the end of a clip within a larger file. Note that Event uses startDate/endDate instead of startTime/endTime, even when describing dates with times. This situation may be clarified in future revisions.
height	Distance or QuantitativeValue	The height of the item.
ineligibleRegion	GeoShape or Place or Text	The ISO 3166-1 (ISO 3166-1 alpha-2) or ISO 3166-2 code, the place, or the GeoShape for the geo-political region(s) for which the offer or delivery charge specification is not valid, e.g. a region where the transaction is not allowed. See also eligibleRegion.
interpretedAsClaim	Claim	Used to indicate a specific claim contained, implied, translated or refined from the content of a MediaObject or other CreativeWork. The interpreting party can be indicated using claimInterpreter.
playerType	Text	Player type required—for example, Flash or Silverlight.
productionCompany	Organization	The production company or studio responsible for the item, e.g. series, video game, episode etc.
regionsAllowed	Place	The regions where the media is allowed. If not specified, then it's assumed to be allowed everywhere. Specify the countries in ISO 3166 format.
requiresSubscription	Boolean or MediaSubscription	Indicates if use of the media require a subscription (either paid or free). Allowed values are true or false (note that an earlier version had 'yes', 'no').

	DateTime or Time	The startTime of something. For a reserved event or service (e.g. FoodEstablishmentReservation), the time that it is expected to start. For actions that span a period of time, when the action was performed. E.g. John wrote a book from January to December. For media, including audio and video, it's the time offset of the start of a clip within a larger file. Note that Event uses startDate/endDate instead of startTime/endTime, even when describing dates with times. This situation may be clarified in future revisions.
startTime		
uploadDate	Date or DateTime	Date (including time if available) when this media object was uploaded to this site.
width	Distance or QuantitativeValue	The width of the item.
Properties from **SoftwareApplication**		
applicationCategory	Text or URL	Type of software application, e.g. 'Game, Multimedia'.
applicationSubCategory	Text or URL	Subcategory of the application, e.g. 'Arcade Game'.
availableOnDevice	Text	Device required to run the application. Used in cases where a specific make/model is required to run the application. Supersedes device.
downloadUrl	URL	If the file can be downloaded, URL to download the binary.
featureList	Text or URL	Features or modules provided by this application (and possibly required by other applications).
memoryRequirements	Text or URL	Minimum memory requirements.
operatingSystem	Text	Operating systems supported (Windows 7, OS X 10.6, Android 1.6).
processorRequirements	Text	Processor architecture required to run the application (e.g. IA64).
softwareRequirements	Text or URL	Component dependency requirements for application. This includes runtime environments and shared libraries that are not included in the application distribution package, but required to run the application (examples: DirectX, Java or .NET runtime). Supersedes requirements.
storageRequirements	Text or URL	Storage requirements (free space required).
supportingData	DataFeed	Supporting data for a SoftwareApplication.
Custom Properties for **Agent**		

mainGoal	Text	Describes the primary objective, aim, or goal that the agent is intended to achieve.
linkedActivity	Activity	Refers to the specific activity or task that the agent is associated with, responsible for, or engaged in.

Geographic

An HSML Class

Entity > **Domain** > **Geographic**

A Domain implicitly or explicitly associated with a location.

Property	Expected Type	Description
Properties from **GeoShape**		
address	PostalAddress or Text	Physical address of the item.
addressCountry	Country or Text	The country. Recommended to be in 2-letter ISO 3166-1 alpha-2 format, for example "US". For backward compatibility, a 3-letter ISO 3166-1 alpha-3 country code such as "SGP" or a full country name such as "Singapore" can also be used.
box	Text	A box is the area enclosed by the rectangle formed by two points. The first point is the lower corner, the second point is the upper corner. A box is expressed as two points separated by a space character.
circle	Text	A circle is the circular region of a specified radius centered at a specified latitude and longitude. A circle is expressed as a pair followed by a radius in meters.
elevation	Number or Text	The elevation of a location (WGS 84). Values may be of the form 'NUMBER UNIT_OF_MEASUREMENT' (e.g., '1,000 m', '3,200 ft') while numbers alone should be assumed to be a value in meters.
line	Text	A line is a point-to-point path consisting of two or more points. A line is expressed as a series of two or more point objects separated by space.
polygon	Text	A polygon is the area enclosed by a point-to-point path for which the starting and ending points are the same. A polygon is expressed as a series of four or more space delimited points where the first and final points are identical.
postalCode	Text	The postal code. For example, 94043.

Concept

An HSML Class

Entity > **Domain** > **Concept**

A type of domain representing intangible concepts and abstract ideas shared by a community of users.

Property	Expected Type	Description
Properties from **DefinedTerm**		
inDefinedTermSet	DefinedTermSet or URL	A DefinedTermSet that contains this term.
termCode	Text	A code that identifies this DefinedTerm within a DefinedTermSet.

Organization

An HSML Class

Entity > **Domain** > **Organization**

A type of domain pertaining to membership within an entity. It can be mapped to **schema:Organization.**

Property	Expected Type	Description
Properties from **Organization**		
acceptedPaymentMethod	LoanOrCredit or PaymentMethod or Text	The payment method(s) that are accepted in general by an organization, or for some specific demand or offer.
actionableFeedbackPolicy	CreativeWork or URL	For a NewsMediaOrganization or other news-related Organization, a statement about public engagement activities (for news media, the newsroom's), including involving the public - digitally or otherwise -- in coverage decisions, reporting and activities after publication.
address	PostalAddress or Text	Physical address of the item.
agentInteractionStatistic	InteractionCounter	The number of completed interactions for this entity, in a particular role (the 'agent'), in a particular action (indicated in the statistic), and in a particular context (i.e. interactionService).
aggregateRating	AggregateRating	The overall rating, based on a collection of reviews or ratings, of the item.
alumni	Person	Alumni of an organization. Inverse property: alumniOf
areaServed	AdministrativeArea or GeoShape or Place or Text	The geographic area where a service or offered item is provided. Supersedes serviceArea.
award	Text	An award won by or for this item. Supersedes awards.
brand	Brand or Organization	The brand(s) associated with a product or service, or the brand(s) maintained by an organization or business person.
contactPoint	ContactPoint	A contact point for a person or organization. Supersedes contactPoints.

correctionsPolicy	CreativeWork or URL	For an Organization (e.g. NewsMediaOrganization), a statement describing (in news media, the newsroom's) disclosure and correction policy for errors.
department	Organization	A relationship between an organization and a department of that organization, also described as an organization (allowing different urls, logos, opening hours). For example: a store with a pharmacy, or a bakery with a cafe.
dissolutionDate	Date	The date that this organization was dissolved.
diversityPolicy	CreativeWork or URL	Statement on diversity policy by an Organization e.g. a NewsMediaOrganization. For a NewsMediaOrganization, a statement describing the newsroom's diversity policy on both staffing and sources, typically providing staffing data.
diversityStaffingReport	Article or URL	For an Organization (often but not necessarily a NewsMediaOrganization), a report on staffing diversity issues. In a news context this might be for example ASNE or RTDNA (US) reports, or self-reported.
duns	Text	The Dun & Bradstreet DUNS number for identifying an organization or business person.
email	Text	Email address.
employee	Person	Someone working for this organization. Supersedes employees.
ethicsPolicy	CreativeWork or URL	Statement about ethics policy, e.g. of a NewsMediaOrganization regarding journalistic and publishing practices, or of a Restaurant, a page describing food source policies. In the case of a NewsMediaOrganization, an ethicsPolicy is typically a statement describing the personal, organizational, and corporate standards of behavior expected by the organization.
event	Event	Upcoming or past event associated with this place, organization, or action. Supersedes events.
faxNumber	Text	The fax number.

founder	Organization or Person	A person or organization who founded this organization. Supersedes founders.
foundingDate	Date	The date that this organization was founded.
foundingLocation	Place	The place where the Organization was founded.
funder	Organization or Person	A person or organization that supports (sponsors) something through some kind of financial contribution.
funding	Grant	A Grant that directly or indirectly provide funding or sponsorship for this item. See also ownershipFundingInfo. Inverse property: fundedItem
globalLocationNumber	Text	The Global Location Number (GLN, sometimes also referred to as International Location Number or ILN) of the respective organization, person, or place. The GLN is a 13-digit number used to identify parties and physical locations.
hasCertification	Certification	Certification information about a product, organization, service, place, or person.
hasCredential	EducationalOccupationalCredential	A credential awarded to the Person or Organization.
hasGS1DigitalLink	URL	The GS1 digital link associated with the object. This URL should conform to the particular requirements of digital links. The link should only contain the Application Identifiers (AIs) that are relevant for the entity being annotated, for instance a Product or an Organization, and for the correct granularity. In particular, for products: A Digital Link that contains a serial number (AI 21) should only be present on instances of IndividualProduct. A Digital Link that contains a lot number (AI 10) should be annotated as SomeProduct if only products from that lot are sold, or IndividualProduct if there is only a specific product. A Digital Link that contains a global model number (AI 8013) should be attached to a Product or a ProductModel. Other item types should be adapted similarly.

hasMemberProgram	MemberProgram	MemberProgram offered by an Organization, for example an eCommerce merchant or an airline.
hasMerchantReturnPolicy	MerchantReturnPolicy	Specifies a MerchantReturnPolicy that may be applicable. Supersedes hasProductReturnPolicy.
hasOfferCatalog	OfferCatalog	Indicates an OfferCatalog listing for this Organization, Person, or Service.
hasPOS	Place	Points-of-Sales operated by the organization or person.
interactionStatistic	InteractionCounter	The number of interactions for the CreativeWork using the WebSite or SoftwareApplication. The most specific child type of InteractionCounter should be used. Supersedes interactionCount.
isicV4	Text	The International Standard of Industrial Classification of All Economic Activities (ISIC), Revision 4 code for a particular organization, business person, or place.
iso6523Code	Text	An organization identifier as defined in ISO 6523(-1). The identifier should be in the XXXX:YYYYYY:ZZZ or XXXX:YYYYYYformat. Where XXXX is a 4 digit ICD (International Code Designator), YYYYYY is an OID (Organization Identifier) with all formatting characters (dots, dashes, spaces) removed with a maximal length of 35 characters, and ZZZ is an optional OPI (Organization Part Identifier) with a maximum length of 35 characters. The various components (ICD, OID, OPI) are joined with a colon character (ASCII 0x3a). Note that many existing organization identifiers defined as attributes like leiCode (0199), duns (0060) or GLN (0088) can be expressed using ISO-6523. If possible, ISO-6523 codes should be preferred to populating vatID or taxID, as ISO identifiers are less ambiguous.
keywords	DefinedTerm or Text or URL	Keywords or tags used to describe some item. Multiple textual entries in a keywords list are typically delimited by commas, or by repeating the property.

knowsAbout	Text or Thing or URL	Of a Person, and less typically of an Organization, to indicate a topic that is known about - suggesting possible expertise but not implying it. We do not distinguish skill levels here, or relate this to educational content, events, objectives or JobPosting descriptions.
knowsLanguage	Language or Text	Of a Person, and less typically of an Organization, to indicate a known language. We do not distinguish skill levels or reading/writing/speaking/signing here. Use language codes from the IETF BCP 47 standard.
legalName	Text	The official name of the organization, e.g. the registered company name.
leiCode	Text	An organization identifier that uniquely identifies a legal entity as defined in ISO 17442.
location	Place or PostalAddress or Text or VirtualLocation	The location of, for example, where an event is happening, where an organization is located, or where an action takes place.
logo	ImageObject or URL	An associated logo.
makesOffer	Offer	A pointer to products or services offered by the organization or person. Inverse property: offeredBy
member	Organization or Person	A member of an Organization or a ProgramMembership. Organizations can be members of organizations; ProgramMembership is typically for individuals. Supersedes members, musicGroupMember. Inverse property: memberOf
memberOf	MemberProgramTier or Organization or ProgramMembership	An Organization (or ProgramMembership) to which this Person or Organization belongs. Inverse property: member
naics	Text	The North American Industry Classification System (NAICS) code for a particular organization or business person.
nonprofitStatus	NonprofitType	nonprofitStatus indicates the legal status of a non-profit organization in its primary place of business.

numberOfEmployees	QuantitativeValue	The number of employees in an organization, e.g. business.
ownershipFundingInfo	AboutPage or CreativeWork or Text or URL	For an Organization (often but not necessarily a NewsMediaOrganization), a description of organizational ownership structure; funding and grants. In a news/media setting, this is with particular reference to editorial independence. Note that the funder is also available and can be used to make basic funder information machine-readable.
owns	OwnershipInfo or Product	Products owned by the organization or person.
parentOrganization	Organization	The larger organization that this organization is a subOrganization of, if any. Supersedes branchOf. Inverse property: subOrganization
publishingPrinciples	CreativeWork or URL	The publishingPrinciples property indicates (typically via URL) a document describing the editorial principles of an Organization (or individual, e.g. a Person writing a blog) that relate to their activities as a publisher, e.g. ethics or diversity policies. When applied to a CreativeWork (e.g. NewsArticle) the principles are those of the party primarily responsible for the creation of the CreativeWork. While such policies are most typically expressed in natural language, sometimes related information (e.g. indicating a funder) can be expressed using schema.org terminology.
review	Review	A review of the item. Supersedes reviews.
seeks	Demand	A pointer to products or services sought by the organization or person (demand).
skills	DefinedTerm or Text	A statement of knowledge, skill, ability, task or any other assertion expressing a competency that is either claimed by a person, an organization or desired or required to fulfill a role or to work in an occupation.
slogan	Text	A slogan or motto associated with the item.

sponsor	Organization or Person	A person or organization that supports a thing through a pledge, promise, or financial contribution. E.g. a sponsor of a Medical Study or a corporate sponsor of an event.
subOrganization	Organization	A relationship between two organizations where the first includes the second, e.g., as a subsidiary. See also: the more specific 'department' property. Inverse property: parentOrganization
taxID	Text	The Tax / Fiscal ID of the organization or person, e.g. the TIN in the US or the CIF/NIF in Spain.
telephone	Text	The telephone number.
unnamedSourcesPolicy	CreativeWork or URL	For an Organization (typically a NewsMediaOrganization), a statement about policy on use of unnamed sources and the decision process required.
vatID	Text	The Value-added Tax ID of the organization or person.

Person

An HSML Class

Entity > **Domain** > **Person**

A special subtype of agent maintaining a self-sovereign identity. It can be mapped to **schema:Person.**

Property	Expected Type	Description
Properties from **Person**		
additionalName	Text	An additional name for a Person, can be used for a middle name.
address	PostalAddress or Text	Physical address of the item.
affiliation	Organization	An organization that this person is affiliated with. For example, a school/university, a club, or a team.
agentInteractionStatistic	InteractionCounter	The number of completed interactions for this entity, in a particular role (the 'agent'), in a particular action (indicated in the statistic), and in a particular context (i.e. interactionService).
alumniOf	EducationalOrganization or Organization	An organization that the person is an alumni of. Inverse property: alumni
award	Text	An award won by or for this item. Supersedes awards.
birthDate	Date	Date of birth.
birthPlace	Place	The place where the person was born.
brand	Brand or Organization	The brand(s) associated with a product or service, or the brand(s) maintained by an organization or business person.
callSign	Text	A callsign, as used in broadcasting and radio communications to identify people, radio and TV stations, or vehicles.
children	Person	A child of the person.
colleague	Person or URL	A colleague of the person. Supersedes colleagues.
contactPoint	ContactPoint	A contact point for a person or organization. Supersedes contactPoints.

deathDate	Date	Date of death.
deathPlace	Place	The place where the person died.
duns	Text	The Dun & Bradstreet DUNS number for identifying an organization or business person.
email	Text	Email address.
familyName	Text	Family name. In the U.S., the last name of a Person.
faxNumber	Text	The fax number.
follows	Person	The most generic uni-directional social relation.
funder	Organization or Person	A person or organization that supports (sponsors) something through some kind of financial contribution.
funding	Grant	A Grant that directly or indirectly provide funding or sponsorship for this item. See also ownershipFundingInfo. Inverse property: fundedItem
gender	GenderType or Text	Gender of something, typically a Person, but possibly also fictional characters, animals, etc. While https://schema.org/Male and https://schema.org/Female may be used, text strings are also acceptable for people who do not identify as a binary gender. The gender property can also be used in an extended sense to cover e.g. the gender of sports teams. As with the gender of individuals, we do not try to enumerate all possibilities. A mixed-gender SportsTeam can be indicated with a text value of "Mixed".
givenName	Text	Given name. In the U.S., the first name of a Person.
globalLocationNumber	Text	The Global Location Number (GLN, sometimes also referred to as International Location Number or ILN) of the respective organization, person, or place. The GLN is a 13-digit number used to identify parties and physical locations.

hasCertification	Certification	Certification information about a product, organization, service, place, or person.
hasCredential	EducationalOccupationalCredential	A credential awarded to the Person or Organization.
hasOccupation	Occupation	The Person's occupation. For past professions, use Role for expressing dates.
hasOfferCatalog	OfferCatalog	Indicates an OfferCatalog listing for this Organization, Person, or Service.
hasPOS	Place	Points-of-Sales operated by the organization or person.
height	Distance or QuantitativeValue	The height of the item.
homeLocation	ContactPoint or Place	A contact location for a person's residence.
honorificPrefix	Text	An honorific prefix preceding a Person's name such as Dr/Mrs/Mr.
honorificSuffix	Text	An honorific suffix following a Person's name such as M.D./PhD/MSCSW.
interactionStatistic	InteractionCounter	The number of interactions for the CreativeWork using the WebSite or SoftwareApplication. The most specific child type of InteractionCounter should be used. Supersedes interactionCount.
isicV4	Text	The International Standard of Industrial Classification of All Economic Activities (ISIC), Revision 4 code for a particular organization, business person, or place.
jobTitle	DefinedTerm or Text	The job title of the person (for example, Financial Manager).
knows	Person	The most generic bi-directional social/work relation.
knowsAbout	Text or Thing or URL	Of a Person, and less typically of an Organization, to indicate a topic that is known about - suggesting possible expertise but not implying it. We do not distinguish skill levels here, or relate this to educational content, events, objectives or JobPosting descriptions.

knowsLanguage	Language or Text	Of a Person, and less typically of an Organization, to indicate a known language. We do not distinguish skill levels or reading/writing/speaking/signing here. Use language codes from the IETF BCP 47 standard.
makesOffer	Offer	A pointer to products or services offered by the organization or person. Inverse property: offeredBy
memberOf	MemberProgramTier or Organization or ProgramMembership	An Organization (or ProgramMembership) to which this Person or Organization belongs. Inverse property: member
naics	Text	The North American Industry Classification System (NAICS) code for a particular organization or business person.
nationality	Country	Nationality of the person.
netWorth	MonetaryAmount or PriceSpecification	The total financial value of the person as calculated by subtracting assets from liabilities.
owns	OwnershipInfo or Product	Products owned by the organization or person.
parent	Person	A parent of this person. Supersedes parents.
performerIn	Event	Event that this person is a performer or participant in.
publishingPrinciples	CreativeWork or URL	The publishingPrinciples property indicates (typically via URL) a document describing the editorial principles of an Organization (or individual, e.g. a Person writing a blog) that relate to their activities as a publisher, e.g. ethics or diversity policies. When applied to a CreativeWork (e.g. NewsArticle) the principles are those of the party primarily responsible for the creation of the CreativeWork. While such policies are most typically expressed in natural language, sometimes related information (e.g. indicating a funder) can be expressed using schema.org terminology.

relatedTo	Person	The most generic familial relation.
seeks	Demand	A pointer to products or services sought by the organization or person (demand).
sibling	Person	A sibling of the person. Supersedes siblings.
skills	DefinedTerm or Text	A statement of knowledge, skill, ability, task or any other assertion expressing a competency that is either claimed by a person, an organization or desired or required to fulfill a role or to work in an occupation.
sponsor	Organization or Person	A person or organization that supports a thing through a pledge, promise, or financial contribution. E.g. a sponsor of a Medical Study or a corporate sponsor of an event.
spouse	Person	The person's spouse.
taxID	Text	The Tax / Fiscal ID of the organization or person, e.g. the TIN in the US or the CIF/NIF in Spain.
telephone	Text	The telephone number.
vatID	Text	The Value-added Tax ID of the organization or person.
weight	QuantitativeValue	The weight of the product or person.
workLocation	ContactPoint or Place	A contact location for a person's place of work.
worksFor	Organization	Organizations that the person works for.

Thing

An HSML Class

Entity > **Domain** > **Thing**

A type of Domain used to represent bounded items without agency. These are objects that have no goals, but that can be used or owned by other Agents to sense or perform an Activity. For example, a camera.

Property	Expected Type	Description
Properties from **Product**		
brand	Brand or Organization	The brand(s) associated with a product or service, or the brand(s) maintained by an organization or business person.
category	CategoryCode or PhysicalActivityCategory or Text or Thing or URL	A category for the item. Greater signs or slashes can be used to informally indicate a category hierarchy.
color	Text	The color of the product.
depth	Distance or QuantitativeValue	The depth of the item.
hasCertification	Certification	Certification information about a product, organization, service, place, or person.
hasEnergyConsumptionDetails	EnergyConsumptionDetails	Defines the energy efficiency Category (also known as "class" or "rating") for a product according to an international energy efficiency standard.
hasMeasurement	QuantitativeValue	A measurement of an item, For example, the inseam of pants, the wheel size of a bicycle, the gauge of a screw, or the carbon footprint measured for certification by an authority. Usually an exact measurement, but can also be a range of measurements for adjustable products, for example belts and ski bindings.
height	Distance or QuantitativeValue	The height of the item.

keywords	DefinedTerm or Text or URL	Keywords or tags used to describe some item. Multiple textual entries in a keywords list are typically delimited by commas, or by repeating the property.
logo	ImageObject or URL	An associated logo.
manufacturer	Organization	The manufacturer of the product.
material	Product or Text or URL	A material that something is made from, e.g. leather, wool, cotton, paper
productID	Text	The product identifier, such as ISBN. For example: meta itemprop="productID" content="isbn:123-456-789".
productionDate	Date	The date of production of the item, e.g. vehicle.
purchaseDate	Date	The date the item, e.g. vehicle, was purchased by the current owner.
releaseDate	Date	The release date of a product or product model. This can be used to distinguish the exact variant of a product.
size	DefinedTerm or QuantitativeValue or SizeSpecification or Text	A standardized size of a product or creative work, specified either through a simple textual string (for example 'XL', '32Wx34L'), a QuantitativeValue with a unitCode, or a comprehensive and structured SizeSpecification; in other cases, the width, height, depth and weight properties may be more applicable.
weight	QuantitativeValue	The weight of the product or person.
width	Distance or QuantitativeValue	The width of the item.
Custom Properties for **Thing**		
owner	Person or Organization	To specify the person or organization that has ownership over the object.
usedByDomain	Domain	To specify the Domain/-s that use this object.

Hyperspace

An HSML Class

Entity > **Hyperspace**

It represents an abstract space containing multiple domains or types of spaces. Hyperspace accounts for both physical and virtual spaces, digital twins, and Internet of Things (IoT) Entities. The focus is on organizing and navigating spatial relationships, as well as maintaining associations between different types of places.

Property	Expected Type	Description
Custom Properties for **Hyperspace**		
containDomain	Domain	A list of domains (e.g., areas or subspaces) within this hyperspace, which could be physical or virtual.
location	Text or URL	The geographical or virtual location of the hyperspace (e.g., latitude/longitude or virtual coordinates).
platform	Text or URL	The name or identifier of the software platform or system to which the item belongs (e.g., Omniverse, Unreal, Unity).
position	PropertyValue	The point's location relative to a reference origin within a 3-dimensional space, defined in x,y,z coordinates.
relatedSpaces	Hyperspace	Other spaces that are related to this hyperspace, possibly through transformations or relations.
rotation	PropertyValue	The orientation of an entity in hyperspace defined with the x, y, z coordinates
spaceType	Text	The type of space this hyperspace represents (e.g., Geographic, Graph, Virtual, Cellular).
transform	PropertyValue	The transform of a space to a different coordinate system by specifying its Position + Rotation + Scale.
volume	PropertyValue	The measure of the volume of an entity defined by its length, width and height dimensions.

Time

An HSML Class

Entity > **Time**

It may be a dimension in spacetime, a length of a duration, a trajectory, related to a clock. When experienced by an Agent, Time has a past, present, and future. Time is related to Hyperspace or to Activities.

Property	Expected Type	Description
Properties from **Schedule**		
byDay	DayOfWeek or Text	Defines the day(s) of the week on which a recurring Event takes place. May be specified using either DayOfWeek, or alternatively Text conforming to iCal's syntax for byDay recurrence rules.
byMonth	Integer	Defines the month(s) of the year on which a recurring Event takes place. Specified as an Integer between 1-12. January is 1.
byMonthDay	Integer	Defines the day(s) of the month on which a recurring Event takes place. Specified as an Integer between 1-31.
byMonthWeek	Integer	Defines the week(s) of the month on which a recurring Event takes place. Specified as an Integer between 1-5. For clarity, byMonthWeek is best used in conjunction with byDay to indicate concepts like the first and third Mondays of a month.
duration	Duration	The duration of the item (movie, audio recording, event, etc.) in ISO 8601 duration format.
endDate	Date or DateTime	The end date and time of the item (in ISO 8601 date format).
endTime	DateTime or Time	The endTime of something. For a reserved event or service (e.g. FoodEstablishmentReservation), the time that it is expected to end. For actions that span a period of time, when the action was performed. E.g. John wrote a book from January to December. For media, including audio and video, it's the time offset of the end of a clip within a larger file. Note that Event uses startDate/endDate instead of startTime/endTime, even when describing dates with times. This situation may be clarified in future revisions.

exceptDate	Date or DateTime	Defines a Date or DateTime during which a scheduled Event will not take place. The property allows exceptions to a Schedule to be specified. If an exception is specified as a DateTime then only the event that would have started at that specific date and time should be excluded from the schedule. If an exception is specified as a Date then any event that is scheduled for that 24 hour period should be excluded from the schedule. This allows a whole day to be excluded from the schedule without having to itemise every scheduled event.
repeatCount	Integer	Defines the number of times a recurring Event will take place.
repeatFrequency	Duration or Text	Defines the frequency at which Events will occur according to a schedule Schedule. The intervals between events should be defined as a Duration of time.
scheduleTimezone	Text	Indicates the timezone for which the time(s) indicated in the Schedule are given. The value provided should be among those listed in the IANA Time Zone Database.
startDate	Date or DateTime	The start date and time of the item (in ISO 8601 date format).
startTime	DateTime or Time	The startTime of something. For a reserved event or service (e.g. FoodEstablishmentReservation), the time that it is expected to start. For actions that span a period of time, when the action was performed. E.g. John wrote a book from January to December. For media, including audio and video, it's the time offset of the start of a clip within a larger file. Note that Event uses startDate/endDate instead of startTime/endTime, even when describing dates with times. This situation may be clarified in future revisions.
Custom properties for **Time**		
date	Date	Represents a specific date. Can be a timestamp (Number), a date string (Text), or an array of date parts.
day	Number or Text	Day of the month (1-31) or day of the week (e.g., Monday).
hour	Number	Represents the hour of the day (0-23 or 1-12, depending on format).
minute	Number	Represents the minute of an hour (0-59).
month	Number or Text	Represents the month of the year (1-12) or the month's name (e.g., January).
second	Number	Represents the second of a minute (0-59).
year	Number	Represents the year (e.g., 2024).

HSML Schema Examples

JSON-LD Context

The *hmsl.jsonld* context file is hosted using GitHub Pages, in the following link:

https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld

This link is to be included in the JSON files as context.

Entity Example

```
1  {
2    "@context": "https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld",
3    "@type": "Entity",
4    "name": "Example Entity",
5    "description": "This is an example entity type.",
6    "swid": "did:key:6MkvWxmpULqn65HWJ7id7GF2G8CGWeGs9GvftPw3ZPESuLC"
7  }
```

Credential Example

```json
{
    "@context":
"https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld",
    "@type": "Credential",
    "name": "Rover 3D Model Access Credential",
    "swid": "did:key:6MkgzpBKiji4aDyZgnfnvk8qwss8p7YbgkAiqFhpK5J6yHN",
    "description":
"This credential authorizes a user from Company A to use the 3D model of the Rover from Compan
y B for simulation and visualization purposes during a 3-month period."
,
    "issuedBy": {
      "@type": "Organization",
      "name": "Company B"
    },
    "accessAuthorization":{
      "@type": "Organization",
      "name": "Company A",
      "identifier":
      {
        "@type": "schema:PropertyValue",
        "propertyID": "SWID",
        "value": "swid:schema:Organization000000000000201"
      }
    },
    "authorizedforDomain":{
      "@type": "Agent",
      "name": "Rover 3D Model",
      "identifier":
      {
        "@type": "schema:PropertyValue",
        "propertyID": "SWID",
        "value": "swid:schema:Agent0000000000000056"
      }
    },
    "validFor": "P3M",
    "validFrom": "2024-12-01T00:00:00Z",
    "validUntil": "2025-02-29T23:59:59Z",
    "validIn": {
      "@type": "schema:AdministrativeArea",
      "name": "Global"
    }
}
```

Agent Domain Example

```json
{
    "@context":
    "https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld",
    "@type": "Agent",
    "name": "unrealActor",
    "swid": "did:key:6MkjhYSEVgRNUkkPSo871xSCDqMpSqeq7QhuN3vT9Hch5bw",
    "url": "objectLink",
    "creator":
    {
        "@type": "Person",
        "name": "Jared Carrillo"
    },
    "dateCreated": "11-12-23",
    "dateModified": "12-05-24",
    "encodingFormat": "application/x-obj",
    "contentUrl": "https://example.com/models/3dmodel-001.obj",
    "platform": "Unreal Engine",
    "spaceLocation":[
        {
            "@type": "Hyperspace",
            "name": "Moon",
            "id": "did:example:Hyperspace123"
        }
    ],
    "description": "Unreal engine object",
    "position": [
        {
            "@type": "schema:PropertyValue",
            "name": "xCoordinate",
            "value": 12.625861403042126
        },
        {
            "@type": "schema:PropertyValue",
            "name": "yCoordinate",
            "value": 4.0042406858753523
        },
        {
            "@type": "schema:PropertyValue",
            "name": "zCoordinate",
            "value": -0.046607494691424937
        }
    ],
    "rotation": [
        {
            "@type": "schema:PropertyValue",
            "name": "rx",
            "value": -0
        },
        {
            "@type": "schema:PropertyValue",
            "name": "ry",
            "value": 0
        },
        {
            "@type": "schema:PropertyValue",
            "name": "rz",
            "value": -0.35816406644629328
        }
    ],
    "additionalProperty": [
        {
            "@type": "schema:PropertyValue",
            "name": "w",
            "value": 0.93365866434508882
        }
    ]
}
```

Organization Domain Example

```json
{
  "@context":
"https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld",
  "@type": "Organization",
  "name": "Jet Propulsion Laboratory (JPL)",
  "alternateName": "NASA JPL",
  "swid": "did:key:6Mkouoo6v6s3FX7CLZaLJx3u6idePgSDQym4ezYz72Q9fSN",
  "description":
"A research and development center funded by NASA and managed by the California Institute of T
echnology, specializing in robotic space exploration."
,
  "url": "https://www.jpl.nasa.gov",
  "logo": "https://en.m.wikipedia.org/wiki/File:Jet_Propulsion_Laboratory_logo.svg",
  "address": {
    "@type": "schema:PostalAddress",
    "streetAddress": "4800 Oak Grove Drive",
    "addressLocality": "Pasadena",
    "addressRegion": "California",
    "postalCode": "91109",
    "addressCountry": "US"
  },
  "telephone": "+1-818-354-4321",
  "email": "info@jpl.nasa.gov",
  "foundingDate": "1936-10-31",
  "parentOrganization": {
    "@type": "Organization",
    "name": "California Institute of Technology (Caltech)",
    "url": "https://www.caltech.edu"
  },
  "employees": [
    {
      "@type": "Person",
      "name": "Laurie Leshin",
      "jobTitle": "Director",
      "sameAs": "https://www.jpl.nasa.gov/people/laurie-leshin"
    }
  ],
  "areaServed": "Global",
  "department": [
    {
      "@type": "Organization",
      "name": "Flight Electronics"
    }
  ],
  "sameAs": [
    "https://www.facebook.com/NASAJPL",
    "https://www.instagram.com/nasajpl/"
  ]
}
```

Person Domain Example

```json
{
  "@context":
"https://digital-twin-interoperability.github.io/hsml-schema-context/hsml.jsonld",
  "@type": "Person",
  "name": "Alicia Sanjurjo",
  "swid": "did:key:6MkidQN81VTZgwTrS9kCsfJ4EJX67ux2qsVhPpUTNoRWqm2",
  "jobTitle": "Intern",
  "worksFor": {
    "@type": "Organization",
    "name": "Jet Propulsion Laboratory (JPL)"
  },
  "affiliation": {
    "@type": "schema:ProgramMembership",
    "name": "JPL Visting Student Research Program (JSVRP)"
  },
  "owns": {
    "@type": "schema:Product",
    "name": "3D Model Collection",
    "hasPart": {
      "@type": "schema:CreativeWork",
      "name": "Lunar Rover 3D Model"
    }
  }
}
```

Bibliography

IEEE Computer Society, C. -A. (2024). *Title: Draft Standard for Spatial Web Protocol, Architecture, and Governance (P2874/D3.1)*. Piscataway, NJ: IEEE.

René, G., & Mapes, D. (2019). *The Spatial Web*.