# NIEM-UML-3

Potential Improvements & Simplifications

As of 7/15/2014 (Rev 0.3)

# Potential improvements

The NIEM-PMO has requested ideas with respect to NIEM-UML-3 based on usage and development experience with NIEM-UML-2. This document is intended to start the process of collecting these ideas and estimating the impact of resolution on the NIEM-UML-3 schedule and level of effort. Note that none of these issues are required as part of the NIEM-3 RFP but any could be addressed under that process.

It should be noted that this issues and suggestions defined below are intended to identify a potential simplification. Substantial design, prototypes and validation would be required to incorporate any such suggestion into the specification.

Several iterations of this document are anticipated as different stakeholders contribute ideas and then the submission team can estimate impact.

## General Information Models (OMG FTF Issue No: 18174)

### Summary:

NIEM has very specific namespace types such as subset, reference and constraints. These correspond directly to NIEM-UML information model types. User experience has shown that segmenting a model in this way is complex for users and couples the PIM design with the PSM (XSD) representation. It would be preferable that, in the PIM, there was a higher level representation.

### Suggested Resolution:

Add an information model kind “General” that can subset any other model(s), add properties and include property redefinitions of cardinality and type. To support this kind of model, augment the QVT such that a General information model produces, as required, subset schema, constraint schema and extension schema that capture the semantics of the general model using legal NIEM schema.

*Note that allowing type substitution in a subset was added to NIEM-UML subset models in the FTF process.*

### Further clarification:

The intended user is the PIM modeler and stakeholders of that model. In an IEPD or EIEM the model representing “Person” could well be spread out over multiple classes: A subset from NIEM core, one or more “augmentation” types, one or more extensions, multiple substitution groups and multiple constraint schema (or schematron). This is difficult and confusing for the modeler but has even more impact on stakeholders trying to understand the model. Our goal should be that in a particular context one domain concept (e.g. Person) should ultimately be represented by exactly one class, even if it is derived from other classes. The NIEM-UML machinery should then take care of segmenting that class according to the NIEM rules. This goal may or may not be fully realized in NIEM-UML-3, but perhaps some improvements can be made. The specific issues that follow contribute to this overall goal.

## Subset Vs. extension schema

NIEM-UML-2, like NIEM-XML, requires that a subset schema be used that is ONLY a subset of a single NIEM reference model and that any extensions to that concept be put in an extension schema. In a general information model it would be preferable to be able to subset and extend in the same model and not always use the same name as the reference model (in which case a “references” would be required to the reference model). In addition, a domain type should be able to “pull” from multiple reference models. The machinery should then be able to match those properties that came from a reference model and create the subset(s) automatically.

## Augmentation Vs. multiple inheritance

NIEM-XML uses “augmentation” to simulate a multiple inheritance capability (Per the NDR). NIEM-UML makes this easier but still requires the explicit definition of something as an augmentation class that is then inherited (or used as a property) in an extension. NIEM-3 eliminates the need for the property with the corresponding reduction in the explicit capability that the extension must be included in any particular class. Augmentation is complex and hard to understand.

### Possible solution

For NIEM-UML a simpler approach would be to not require the specific declaration of an augmentation type, but rather to allow multiple inheritance. To provide for XSD rules the “augmenting” inheritance would be marked as “augmented by”. This is instead of the current style of marking what is augmented and having an explicit augmentation type. For forward compatibility and reference models “augments” could still be supported. The result would be the generation of an augmentation type as required by the NDR. As a result ANY type could be used as an augmentation (even if it was also used for other purposes), even if not originally defined as such.

Once issue complicating resolution is that the cardinality of augmenting types is unclear. For simulating multiple inheritance there should be exactly one augmenting instance for the “multiply inherited” type. NIEM allows multiples – which doesn’t seem to make much semantic sense. Perhaps this could be addressed by NTAC.

## Multiple subsets of the same type

It is common that, within the same IEPD or EIEM, but in different context or purposes, there is a need for different combination of properties from reference models. E.g. a “person” that is a “subject” may need different properties than a “person” that is an “officer”.

A NIEM subset (e.g. of person) must have the same name and namespace as the corresponding element in a reference model. This NIEM design choice effectively prevents the same element from being subset differently for different purposes. A “work around” is that a “subset” can be defined that is the unification of all possible properties from all desired uses of the reference element. A “restriction” can then be made for each different purpose and then (if needed) an extension of each of those restricted subsets defined to make the final desired element (e.g. “officer”).

The other work-around is just to have the “unified subset” and ignore the unneeded properties (they would then need to be marked as optional in the subset). Ignoring the correct properties is then a matter of documentation.

So while possible, the NIEM solutions are overly complex, couple the different purposes into a unified subset and make the resulting model difficult to interpret. Note that this is an issue with NIEM-XML as well as NIEM-UML.

### Possible solution

When the modeler is creating domain specific types (e.g. “officer” or “subject”) each would be allowed to include an arbitrary subset of reference model(s) properties as well as add new properties. The NIEM-UML machinery would then create the required unified subset, restrictions and extensions. So in the domain model a single “officer” type would fully define the needs of that type.

An ancillary capability would be for the single type to include subset properties from multiple reference models as the properties for a single type are often spread across multiple reference models and augmentations.

## Substitution groups as property holders

Substitution groups allow for multiple variations on a property. As with any property, most substation group “heads” are specific to a particular domain (e.g. PersonRace is clearly a property of Person). In NIEM-UML the definition of a substitution group is required to be in a separate property holder. This distributes the concepts of the domain type (Person) over these property holders and adds substantial complexity.

### Possible resolution 1:

It would be preferable to define the substitution group within the context of its domain (including the “subset” choices). Where the “head” does not have a clear domain it is still acceptable to define a property holder as was the intent for property holders originally.

This behavior was demonstrated in early NIEM-UML prototypes. Mid-stream in the NIEM-UML-2 process there was an issue raised that such a pattern would prevent extension of a substitution group. However, no such issues seems to exist – the same mechanism used now to extend a substitution group (define a subtype with subset properties) could be used with an imbedded substitution group, such an extension may or may not be a property holder based on context.

### Possible resolution 2:

Represent substitution groups as either subclasses or union types. See issue 11), below.

## Entities Vs data elements

There is an essential conceptual different between identifiable entities like people and organizations and “data values” like strings and phone numbers. The common thought is that the “identity” of a value is identical to its content, and that a value’s content can’t change. Alternatively, an entity has an independent identity and properties of an entity can change over time. In NIEM there are some clear values – all those derived from or encapsulating XML primitive types. There are also choices that could be made for other values (like address). UML contains this distinction in classes vs. data types.

There are multiple advantages to this distinction – for one thing aggregation should always be used for data types (you can’t reference something without an identity). One thing this impacts is the generation of UML diagrams – where associations should be used between entities, but not to values. Since this information is lost the diagrams have to be hand-tuned.

### Possible solution

NIEM-UML should use data type for values and classes for entities. Values should always be shown as UML properties.

Like some other issues, this pattern was suggested in the NIEM-UML-2 process. The reason it was abandon is not clear.

## Reducing the need for property holders

Property holders were introduced to solve an “edge case” where a property was defined in a reference model but not used as the property of class in that model. It is unlikely that a UML modeler would ever want a property holder, they would make a class to hold any property.

To solve various problems property holders have grown in usage. They essentially constitute “noise” in the UML model and should not be required except for the edge case.

## Usability of reference models

The NIEM-UML reference models are reverse-engineered from the XML schema – and this makes a great deal of sense for repeatability and reliability. However, the resulting models suffer usability problems. These include property/association choices, use of the “lower level” representation of concepts like roles and augmentations, etc. It also results in auto-generated diagrams. The result is it may be hard to make the IEPD model look like what we would want and the reference models are hard to navigate.

### Possible solution

Three things may help make the reference models more usable: 1) Tuning of the reverse engineering to better make use of the higher level concepts. 2) Manual tuning of these models. 3) Manual creation of reference model diagrams.

Note that the manual creation of reference model diagrams would be a substantial effort – but would be a real aid for users finding and reusing reference concepts.

## Aggregation commitment

NIEM-2 (and NIEM-UML-2) suffered a problem of “early commitment” to aggregation or reference – particularly in the reference models where choice was made and was frequently wrong for a particular usage. NIEM-3 inverted this and now makes no commitment to either and removes the capacity to make such a distinction. This is highly unusual for both UML and XSD modelers who are used to defining aggregation and having XML instances with a particular structure. It is interesting that RDF also does not make any such distinction and this results in the serialization of RDF instances being inconsistent and hard to parse. The result of the current policy is that users will have trouble decoding an arbitrary serialization of any NIEM instance and it will not be clear how to diagram classes.

### Possible solution

NIEM-UML-3 should allow for “no commitment” (the current NIEM policy), particularly in reference models but also allow for a commitment in a specific IEPD or EIEM. It may be acceptable to make “aggregation” an optional constraint (using “black diamond”) and then allow “no commitment” to be either. If “values” are distinguished as data types (see above), values should always be aggregated properties.

The aggregation commitment should be reflected in the schema in some way, TBD. Perhaps as annotations – this should be addressed by NTAC.

## NIEM Association Types

NIEM association types should, perhaps, be reverse engineered as association classes.

Example: Person-Organization-Association is an association class that connects Person to Organization, along with some additional properties that decorate the association. It’s not a class that has independent meaning.

Issue: NIEM associations have less than 2 ends and add ends in other schema. UML associations must have 2+ ends and you can’t add ends (which seems like an unnecessary constraint, but that is how it is). To address this issue a more sophisticated rule would have to be investigated or association types with these issues would have to receive special treatment.

Potential resolution: More sophisticated reverse engineering as well as manual adjustment of associations with issues.

## Treatment of union types and substitution groups

The treatment of union types is NIEM remains poor. Entity is (logically) the union of (or supertype of) Person and Organization. We’ve interpreted every class with a “Representation” property as a union of the things appearing in the representation property holder. I understand that a true union class would prevent adding new representation options. However, in UML, it would be useful to assert that an object class is the union of several other classes, with the understanding that the union may have new options added in the future (a horrible violation of the unionOf construct in OWL).

Example: As it is modeled in NIEM, Entity is a composition of persons and organizations. However, at least as I understand the legal concept, an Entity is (a subset of?) the union of Persons and Organizations. So, I would expect to see specialization arrows between Entity and Person and between Entity and Organization. By treating Entity as a composition, two problems arise: 1) An entity can contain multiple persons via the Entity-Representation substitution group, which means that an Entity is no longer “a person …” but rather “a collection of persons …” 2) Whenever Entity appears in a domain model (e.g., as the target of the Applicant property), an additional level of indirection is needed (/Application/Applicant/Entity-Person/Person-Name) instead of (/Application/Applicant/Person-Name). If you want to indicate that Insurance-Applicant can only be a natural entity (i.e., a Person), you have to create a restriction type and apply a type override.

Potential resolution: Treating “representations” as union types ends up being a different representation for “substitution groups” (this is where the “representation” names come in) – note that in 5) we also suggested a change to substitution groups so we would have 2 representation options to look at.

Note that in UML it would be more “normal” to use polymorphism and subtypes rather than multiple properties such as are found in substitution groups. Some thought would have to be given to how a union and its members would relate to the multiple NIEM properties.

## Unnecessary Reified relationships (Association classes)

Association classes are reified relationships. In many cases, the reification is unnecessary. There should be some mechanism wherein a simple association (property) could be used.

Example: a Person-Employment-Association can be simplified down to Employs (or Employed-By).

Resolution: No resolution to this issue has been found. While a UML representation is possible, there is no known way to express this in NIEM-XML. It is noted that OWL-2 is capable if expressing such a simplified property.

# Impact

As an initial estimation the above issues are categorized from 1 (minimal impact on effort or schedule) to 10 (essentially a re-design of NIEM-UML).

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| Issue | Impact Estimate |
| General Information Models (OMG FTF Issue No: 18174) | 5 |
| Subset Vs. extension schema | 4 |
| Augmentation Vs. multiple inheritance | 2 |
| Multiple subsets of the same type | 3 |
| Substitution groups as property holders | 2 |
| Entities Vs data elements | 1 |
| Reducing the need for property holders | 2 |
| Usability of reference models | 4 |
| Aggregation commitment | 2 |
| NIEM Association Types | 3 |
| Treatment of union types and substitution groups | 3 |
| Unnecessary Reified relationships (Association classes) | Unknown |

# NTAC Action Items

Potential resolution is requested of NTAC for issues: 3, 9, 11, 12

These issues could impact or restrict the XML representation.