A Mapping from Shlaer-Mellor to UML

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1. Background

The purpose of this paper is to present a mapping between Shlaer-Mellor concepts and their representations in UML. The objectives of this mapping are to:

- bring executable and translatable models to the UML community
- enable interchange between Shlaer-Mellor tools and UML tools
- bring the terminology as close as possible to UML so that the models “look like” UML
- introduce as little dissonance as possible for native Shlaer-Mellor users

The ideas presented here are the results of work that builds on the ideas presented in earlier papers [M14,M15]. These earlier papers established the basis for using the UML notation to represent Shlaer-Mellor models but did not examine many aspects of the formalism in any detail. In particular the justification for the choices of mapping had not been fully established with respect to the UML metamodel. This issue is vitally important if it is to be possible to interchange models between tools while preserving their semantic content.

This latter issue is also becoming of greater importance to the wider UML community. In its current form UML is designed to support a wide variety of different modelling techniques and formalisms. This is evident, for example, in the state machine formalism which allows both Moore and Mealy formalism with hierarchical states including concurrent sub-states and both synchronous and asynchronous calling semantics. The result of this is not only that almost any state modelling style can be supported but also that many combinations of elements have no defined execution semantic\(^1\). It is now widely recognised within the UML community, however, that considerable benefit can be gained by forming subsets of the UML with well defined execution semantics. Such subsets can form an “executable UML” which would

\(^1\) These are termed “Semantic Variation Points” in the UML specification
enable the simulation, execution, testing and ultimately translation of UML models into target code. As part of this movement, work is progressing under the auspices of the OMG towards the definition of “profiles” that define such subsets and towards the more detailed definition of the contents of “actions” including a more precise definition of the execution semantics of UML models.

This paper, then, describes an executable UML “profile”.

This paper presents a combined approach encompassing the various different flavours of the Shlaer-Mellor method. Throughout this paper we will refer to the various flavours, which are described in more detail in section 11.

Finally, this work is not complete. Although all the elements of the Shlaer-Mellor method have been enumerated and tentative mappings identified (see section 12), we have not yet fully established all the implications. We welcome comments from the reader.

2. Principles

To make the mapping regular, we have to have a set of mapping principles that we can apply as uniformly as possible throughout. We discuss below the use of names, stereotypes, and tags.

On Names. One purpose of this paper is to present a mapping between Shlaer-Mellor concepts and their representations in UML. To maintain complete and clear domain separation between two, it would be best to maintain two entirely different vocabularies, which would yield statements of the form “Represent a (Shlaer-Mellor) object as a box with three compartments....” This mapping, then, is from the concept to its representation, an icon. However, the box-with-three-compartments represents a ‘class’ in UML, and users of UML will always refer to the box-with-three-compartments as a class, for that is what it is.

The approach to naming taken in this paper is therefore as follows.

The notational mappings are generally presented as:

“Represent <Shlaer-Mellor concept> as <notational element>”

We name each notational element using UML terminology; (i.e. a ‘Box-with-several-compartments’ is referred to as a ‘Class’). This reduces dissonance when reading a UML model based on the notational elements under discussion. This also renders the use of this mapping in UML compliant tools more straight forward.

However, for certain notational mappings (for example those that use the Package Diagram\(^2\)) referring to the UML representation simply by its representation type will be inadequate. For those situations we will use the Shlaer-Mellor terminology.

\(^2\) We should not be surprised by this as the Package concept in UML is intended to be able to capture a wide variety of different packaging concepts. It is inevitable that any use of packages in UML will have to supply some method specific names.
On Stereotypes. A stereotype in UML is a way of introducing a new class of modelling element within a model. A stereotype can only specialize an existing class in the metamodel. A stereotype is shown between guillemets << and >>.

We use a stereotype to distinguish one use of a symbol from another, in a manner that extends the UML metamodel. For example, we shall use the package diagram to model both subsystems and domains. Because the UML makes no distinction between these two concepts and we use the same diagram for both, there must be a way to distinguish between them.

We also define a stereotype as high up in the model hierarchy as possible so that the stereotype appears as few times as possible. For example, we can stereotype the a UML Class Diagram as a (Shlaer-Mellor) Class Model so that all attributes on that model are required to be atomic.

On Tags. Tags are used to add arbitrary information to the models, but not to extend the meta-model. Tags are represented as a comma-delimited sequence of specifications, surrounded by braces {}. Each specification may be simply a keyword (a tag), or a keyword with a value (a property), expressed as keyword = value. Keywords and values are simply strings.

We use tags to add information about a model element in a manner that does not extend the metamodel of UML. For example, we shall use a tag to indicate mathematically dependent attributes.

Often, we use tags to represent Shlaer-Mellor concepts such as Numbers and Key Letters. These are present in Shlaer-Mellor to aid readability and to support model management. As such they are not central to the formalism itself and may be omitted from diagrams if desired. In this paper we will always show such tags in order to demonstrate what they look like if present.

3. The Domain Chart

Represent the Domain Chart using a Package Diagram.

The package diagram representing a domain chart is stereotyped to allow only packages with no contents, and no tags or other names on the dependencies.

![Diagram of a domain chart with Shlaer-Mellor notation](image)

**Figure 1 - Example Domain Chart with Shlaer-Mellor Notation**

Figure 1 shows an example domain chart with the equivalent UML package diagram in Figure 2 below.
4. Subsystem Models

Subsystem Relationship Model. Represent the Subsystem Relationship Model as a Package Diagram.

The package diagram representing the subsystem relationship model is stereotyped to allow only packages with no contents.

Name each package as a triple comprising the subsystem name, the prefix, and the object number range.

Name each dependency between packages with the relationship identifiers expressed as tags. For example, express the relationships R10 and R182 as the tags { R10, R182 }.

Use a single dependency arrow in an arbitrary direction.

Subsystem Communication Model. Represent the Subsystem Communication Model as a Package Diagram.

The package diagram representing the subsystem communication model is stereotyped to allow only packages with no contents.

Name each package as a triple comprising the subsystem name, the prefix, and the object number range.

Name each dependency between packages with the event identifier and name expressed as property specifications. For example, express the events DTN21: Reschedule on disruption and TOM8: Switch to new schedule as { DTN21 = Reschedule on disruption, TOM8 = Switch to new schedule }.

Use the dependency arrow to point in the direction that the events are being sent.


The package diagram representing the subsystem access model is stereotyped to allow only packages with no contents.

Name each package as a triple comprising the subsystem name, the prefix, and the object number range.
Name each dependency between packages with the process identifier expressed as tags. For example, express accesses to the processes DTC.2, DTZ.4 as { DTC.2, DTC.4 }.

Use the dependency arrow to point in the direction of the access.

5. **Object Information Model**

Represent the Shlaer-Mellor Information Model using a UML Class Diagram.

The class diagram representing the object information model has several stereotypes that apply to the model as a whole and apply to each of the kinds of elements that may appear on the model. We describe each stereotype below when we describe each kind of model element.

**Objects.** Represent a Shlaer-Mellor object using a UML Class. The class has three compartments:

- the name compartment, which contains the name comprising three parts, the object number, object name, and key letter
- the attribute compartment (see section below) and
- the operation compartment (see section below)

Represent an imported object using italics for the name, with a note reading “(from <subsystem name>)”

**Attribute.** Represent an attribute with its name, a colon, and its type. (See the subsection on typing below.)

We stereotype the class diagram that represents an object information model to require attributes to be single valued.

Represent an identifying attribute with a tag { I=2 }, { I=2 }, { I=33 }… If an attribute participates in multiple identifiers, the tags may be strung together as { I=1,2 } etc.

Represent a referential attribute with a tag corresponding to the relationship number(s), i.e. { R=2,4 }

Represent a constrained referential attribute by extending the tag to have the letter ‘c,’ i.e. { R=2c }

Represent mathematically dependent attributes with a tag { M }.

**Types.** Represent the domain-specific data type as a string.

Separately, define the domain-specific data type in terms of its base types as defined in *Data Types in OOA* [M4] or the ASL Reference Manual [M10]

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**Operations.** Shlaer-Mellor does not show operations on the object information model. However, the UML class diagram does allow operations, and there are potential uses for them in Shlaer-Mellor OOA, such as data accessors, transformers or synchronous services\(^3\). Whether or not these are shown is optional.

Represent a read accessor as an operation with isQuery = true. Use the standard UML syntax for the operation, i.e. `OperationName( ParameterName : ParameterType = DefaultValue, … ) : ReturnType`. Do not include the instance identifier.

Represent a write accessor as an operation.

Represent a (publicly accessible) transformer as an operation with the tag `{ Transform }`.

Represent a synchronous service as an operation with the `OperatioName` being the name of the synchronous service. Do not include the key letter and service number as part of the name. These are modelled as tags on the operation.

**Relationships.** Represent a relationship as a class association, with the multiplicity and conditionality using numbers as in UML (i.e. `1c \rightarrow 0..1, M \rightarrow 1..*`).

Represent the relationship identifier (i.e. R2 or R4) as an association name. Use the same approach for relationships constructed by composition: `R3 = R2 + R4`.

Represent the relationship roles names as association roles, such as ‘owns’ and ‘is owned by.’\(^4\)

**Associative Objects.** Represent an associative object as an association class. Note that in the UML metamodels, the association and the association class are indistinguishable entities. This has the effect that Shlaer-Mellor “many-associative” relationships (e.g. M-(M:M) or M-(1:M) etc.) cannot be modelled directly in UML. Instead, for such situations analysts must create an additional class with a M:1 association with the original association class.

**Associative Objects with Assigners.** Show an associative object with an assigner with a stereotype `<<assigner>>`.

**Note** that this stereotype can designate *two* classes expressed as one on the graphic. The name of the “base” class is as given by the user “5, Dog Adoption, DA” and the assigner is name “<null>, Dog Adoption-A, DA-A”. This will allow us to build two state models in a UML repository.

**Sub/Supertype Relationships.** Represent a sub/supertype relation using the UML generalization relation.

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\(^3\) According to method flavour. Note that we would not normally show “Event Taker” operations on the class since these represent only one style of implementation of state machines. Other, different styles are possible. We consider the State Machine to be a separate part of the formalism from the operations shown on the class diagram.

\(^4\) Note that the classic UML “style” (as used in the many books) is to use nouns as roles on associations. However, the UML standard does not dictate this and allows for the Shlaer-Mellor style verb phrases. We maintain that such verb phrases have many advantages over the noun style.
We stereotype the class diagram to require the tag \{complete, disjoint\}. This information may be expressed visually on a model at the tool vendor’s option.

Represent sub/supertype relationship numbers as tags \{Rn\}.

Note that in the UML, generalisation is not the same thing as inheritance. Rather, inheritance is a set of mechanisms that can be applied to a generalisation hierarchy. Such an application is not, however, compulsory. Indeed, the UML specification makes it clear that using inheritance makes it difficult to model multiple classification and indicates that other approaches might be more appropriate in this context. We suggest that the Shlaer-Mellor sub/supertype concept is such an approach. In the Shlaer-Mellor view of generalisation then, we think of the superclass as having instances (objects) that are distinct from, but associated with the subclass instances.

![Figure 3 - A section of a Shlaer-Mellor Information Model](image)

The example information model fragment shown in Figure 3 will become the UML class diagram fragment shown in Figure 4.

![Figure 4 - UML Class Diagram Fragment](image)

6. **Object Communication Model**

Represent the Shlaer-Mellor Object Communication Model (OCM) using a UML specification level collaboration diagram.

* **Objects** Represent the Shlaer-Mellor object’s state model (OOA91) or the object (OOA97) by a role on the collaboration diagram. Name the role with the name of the object. Draw a line between those objects that communicate with each other.

* **Event Transmissions** Represent asynchronous communications (event transmissions in OOA92 and
OOA97) by arrows with a half arrow head in the style of UML asynchronous message. Label the message with the event meaning (name) from Shlaer-Mellor. Indicate the key letter and event number with tags.

**Synchronous Invocations** Represent synchronous service invocations (from OOA97) by a arrow with full arrow head in the style of a UML synchronous message. Label the message with the service name from Shlaer-Mellor. Indicate the key letter and service number with tags.

**Terminators** Represent terminators as interfaces classes with a role on the collaboration diagram. Name the role with the name of the terminator. Stereotype type the role as <<interface>>.

**Domain Based Services** To represent invocations/transmissions from OOA97 domain based services, place a role on the collaboration diagram to represent the class corresponding to the domain itself. Name the role with the Key Letter of the domain.

**Options** The key letter and event/service number tags may be omitted if required.

**Example**

The following Shlaer-Mellor diagram:

![Collaboration Diagram](image)

**Figure 5 - An example Shlaer-Mellor OCM**

(where dotted lines represent asynchronous communication and solid lines represent synchronous invocations), becomes:
7. State Models

In Shlaer-Mellor a state model has two representations; The State Transition Diagram (STD) and The State Transition Table. We detail the mapping of these representations and the components of the underlying state model that they represent.

Representations

State Transition Diagram Represent the Shlaer-Mellor STD using a UML stereotyped UML state chart. The stereotyping constrains the chart not to use heirarchical states.

State Transition Table Represent a Shlaer-Mellor STT as a sterotyped tabular representation. Label the OOA92 "Non-existent" state as "Initial State".

States

States Represent Shlaer-Mellor states as states on the state chart. Name the states using the name from the Shlaer-Mellor state. Number the states using tags.

Deletion State Represent a Shlaer-Mellor deletion state (i.e one in which self deletion occurs and the box is shown as dotted) by a UML state with an unlabeled (completion) transition to the final state vertex. If there are multiple deletion states then create multiple transitions to the single final state vertex.

Quiescent State Represent a quiescent state (i.e. one in which self delection does not occur, but has no outgoing transitions) as a state on the UML state chart with no outgoing transitions.

State Action Model the Shlaer-Mellor state action as a UML entry action on the corresponding state
Events

Event  Represent Shlaer-Mellor events as signal events on the state chart. Label the signal event with the event meaning (name) from Shlaer-Mellor. Indicate the key letter and event number with tags.

Self Directed Event  Represent a Shlaer-Mellor self directed event as a UML "completion transition". This guarantees the correct semantics for the transition. However, to avoid confusion for those used to Shlaer-Mellor models, label the transition with the appropriate event.

Event Parameter  Represent Shlaer-Mellor supplementary event data (event parameters) as signal event parameters.

Polymorphic Event  Represent OOA92 style polymorphic events as signal events with a key letter appropriate to the superclass to which they are directed. Such events should be placed used to label transitions as appropriate on subclass state charts. To allow for key letters not being shown on the OCM or the state chart, event names must be unique across the entire hierarchy.

Represent OOA96 style polymorphic events by creating a Polymorphic Event Table providing a mapping from the superclass signal events to the appropriate subclass events. In this case even names need only be unique within a particular class.

Effects

Transition  Represent a Shlaer-Mellor state transition as a transition on the UML state chart. Label the transition with the signal event corresponding to the appropriate Shlaer-Mellor event.

Creation Transition  Show a Shlaer-Mellor creation transition on the UML state chart as a transition from the initial state vertex to the creation state. If there was more than one creation state/transition, then this should be shown as multiple transitions from the single initial state vertex.

Ignore  Represent the Shlaer-Mellor "ignore" response on the UML state chart by showing an internal transition on the appropriate state labeled with the signal event which is ignored. Show no action for the transition.

Cannot Happen  Represent the Shlaer-Mellor "cannot happen" response on the UML state chart by showing an internal transition on the appropriate state labeled with the signal event which "cannot happen". Show a stereotyped action "cannot happen" for the internal transition.

Shouldn't Happen  Represent the OOA97 "shouldn't happen" response on the UML state chart by showing an internal transition on the appropriate state labeled with the signal event which "shouldn't happen". Show a stereotyped action "shouldn't happen" for the internal transition.

\[5\text{"cannot happen" is a UML "raise" action that causes raising of an exception.}\]

\[6\text{"shouldn't happen" is a UML "raise" action that causes raising of an exception.}\]
**Hold**  Represent the OOA97 "hold" response on the UML state chart by showing an internal transition on the appropriate state labeled with the signal event which is to be held. Show a UML "defer" action for the transition.

**Options**

The keyletter, state number and event number tags may be omitted if required. Internal transitions will not normally be shown if the STT notation is also employed.

**Example**

The following Shlaer-Mellor state transition diagram:

1. Creating Pre-Paid Transaction
   Action 1
   TX1: Pre-Paid Transaction Started(pump_no)

2. Creating Manual Transaction
   Action 2
   TX2: Manual Transaction Started(pump_no)

3. Transaction in Progress
   Action 3
   TX3: Transaction In Progress(pump_no)

4. Transaction completed
   Action 4
   TX4: Transaction Complete(pump_no, fuel_quantity)

becomes a UML state chart as follows:
8. Assigner State Models

Represent an OOA91 assigner state model by a state chart stereotyped as <<assigner>> attached to the associative class. The stereotyping prohibits creation states, deletion states and polymorphism. Label events with a key letter in the form "<class kl>-A".

Represent an OOA96 assigner state model by a state chart stereotyped as <<assigner>> attached to the partitioning association. The stereotyping prohibits creation states, deletion states and polymorphism. Label events with a key letter in the form "R<association number>-A".
9. Synchronous Operations

Represent OOA92 and OOA97 style synchronous services as UML operations with the corresponding
service actions as UML methods\(^7\). The invocation of such operations is shown on the OCM as described
previously. Optionally, the services can also be shown in the Class Diagram.

10. Acknowledgements

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In particular, SJM would like to thank....

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and Paul Francis. Andy Land deserves special praise for the painstaking care with which he picked his
way through the 300+ pages on the UML specification in order to ensure the correctness of the mappings.

\(^7\) Note that UML 1.3 does not allow methods to have “actions”. This is certain to be changed in the
“Precise Action Semantics” enhancement to UML currently being defined under the auspices of the OMG.
11. Method Baselines

Since the publication of the first book on OOA by Shlaer and Mellor various clarifications and extensions have been issued. In addition, others have contributed ideas, many of which are in active use. The intention of this section is to summarise these so that the discussion of the mapping to UML may be seen in context. It is not intended that this in any way replaces the published definitions of these extensions and in case of doubt the original publications should be consulted.

A complication in defining clear versions of the method is that there have often been a continuous series of minor improvements that have been incorporated into, for example, training material or consulting work on real projects without there having been an "official" and published release. Nevertheless, it is useful and convenient to attempt to define such versions.

11.1 OOA 88

This method, described in [M1] is confined mainly to Information Modelling with a minimal treatment of dynamic modelling and “design by translation”.

11.2 OOA 91

The method as published in “Object Lifecycles: Modelling the World in States” [M2], represents the first virtually complete description of OOA as we might recognise today. It differs from OOA 88 in the following respects:

- Minor Improvements to the Information Modelling formalism and notation such as Numbered Relationships.

- Substantial definition of dynamic behaviour in terms of interacting state machines executing models represented by State Transition Diagrams and State Transition Tables. Included with this was a treatment of the rules of synchronisation and concurrency within an OOA model.

- Introduction of the idea of domain partitioning with an outline treatment of bridges.

- A discussion of the Software Architecture that emphasised the idea of translation as system construction approach.

11.3 OOA 92

While developing CASE tool support that understood the formalism Kennedy Carter extended the definition and notation some areas. Most of these issues were documented in the product’s User Guide, although some technical notes were written.

The following issues were addressed:

Information Models

The following changes were made:
• The case of a general n-way relationship that had briefly been mentioned in OOA 88 but omitted from OOA 91 was withdrawn completely from our support. Our experience was that such relationships are very hard to understand and the real-world issues that they represent are better described by a number of simpler relationships.

• The notion of an "attribute domain", which was informally described in OOA 91 was tightened to include the idea of a data type with optional constraint.

*State Models*

In order to make the STT representation a complete description of the state model the following were added:

• A row representing the state of an instance before its creation. This pseudo-state enables the STT to show creation transitions. In addition, it allows the analyst to distinguish between the arrival of an event targeted at a non-existent instance being an error ("Cannot Happen") and being expected ("Ignore").

• The addition of the effect "Meaningless" for events arriving for instances in a state where the instance is deleted.

Other changes were:

• The notion of a polymorphic event was formally introduced [M12,M13].

• The idea of “synchronous services” was introduced [M7]. Such services specify processing that is executed synchronously with respect to the invocation and can return data to the invoking state action. OOA 97 refined the ideas and introduces the formal association of such services with objects and with object instances.

• Self directed events go to the head of the event queue for an instance. (Previously this was a recommendation only).

*Process Models*

• The Action Specification Language (ASL) [M10] was introduced as an alternative to Action Data Flow Diagrams (ADFDs) for specifying process models.

*Domains and Bridges*

• Introduction of an “OOA of Bridges” describing all the possible bridges mappings that can exist between OOA domains [M8].

• Interaction with other domains captured through events being sent to/from terminators. Guidelines were provided for the level of abstraction for the terminator (i.e. that the terminator

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8 In OOA 97 the idea of an event being sent to a terminator was replaced with a “terminator service invocation” akin to a wormhole [M6].
represents the “ultimate source or sink” of a structured analysis “essential model” rather than the domain that implements it).

11.4 OOA 96

The “OOA 96 Report” [M3] tidied up a number of a number of loose ends in the description of OOA 91 and introduced some additional concepts. Some of these concepts had previously been described in Project Technology training material, but not incorporated in an “official” description of the method.

In outline the areas addressed were:

**Information Models**

- Clarification of the ideas of mathematical and stochastic dependence of attributes. Introduction of the notation (M) for mathematically dependent attributes replacing the (D) notation used previously.

- Clarification of the idea of relationship loops and composed relationships.

- Clarification to the ideas of reflexive relationships and the introduction of a new special case of symmetric reflexive relationships.

**State Models**

- Notational distinction between identifying event parameters and supplemental data.

- Events can no longer be sent to terminators.

- Self directed events go to head of the event queue for an instance.

- Formal introduction of polymorphic events through the idea of a “Polymorphic Event Table”

- Clarification to the definition of the operation of the Finite State Machine mechanism.

- Occurrence of “Cannot Happen” at run time defined as an analyst error.

- Introduction of the new concept of “multiple assigners”

- Clarifications to the rules surrounding object instance creation and deletion

**Process Models**

- Process models are not longer allowed to access the “Current State” attribute of an active object (except in the special case of synchronous creation).
• Introduction of the “proper attribution” rule for transient data on ADFDs.  

• Introduction into ADFDs of the ideas of “base processes” working on (possibly ordered) sets of data, thus formally supporting the idea of iteration.

• Changes to the allowable properties of different process types on ADFDs.

• Replacement of the “Timer” mechanism with a simpler “Delayed Event” mechanism.

• Introduction of the term “wormhole” to refer to the invocation of services provided by other domains.

11.5 OOA 97

OOA 97 was an accumulation of a number of issues that built up in the course of consultancy work. These issues were then gathered into a single OOA 97 document [M9].

• Refinement of the idea of synchronous services by formal association of services with domains, objects and instances of objects. In ASL this association was captured with a defined syntax for the service calls.

• Introduction of the additional FSM responses of “Hold” and “Shouldn’t Happen”. The first of these was to deal with a specific class of problem complexity, the second in response to the OOA 96 rules that classify “Cannot Happen” as an analysis error if it does happen.

• Introduction of exception handling mechanisms within the OOA formalism.

• Introduction of support from the formalism for both “Deferred” and “Dynamic” data types.

• Introduction of a comprehensive support for the definition of Bridges within OOA/ASL including the idea of “counterpart relationships”.

In order to support these ideas, the definition of ASL was upgraded from ASL 2.4 to ASL 2.5.

11.6 OOA 96++

Since the OOA 96 report, Shlaer and Mellor issued further method documents [M5, M6, M7] on the subjects of Data Types, Bridges & Wormholes and Synchronous Services. For convenience we refer to these as OOA 96++.

• Introduction of formal notion of a Data Type with a base type, range and precision and units

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9 This rule has been subsequently refined to the idea that all transient flows should have a defined type [M4].
• Introduction of idea of wormholes with client-server associations managed through transfer vectors

• Introduction of idea of a synchronous service provided by a domain.
12. Shlaer-Mellor to UML Meta-Model Mapping

The following table outlines the mappings between Shlaer-Mellor modelling concepts and the UML meta-model. These mappings have been chosen to be strictly correct in terms of the definition of the semantics behind the meta-model.

<table>
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<th>Shlaer-Mellor Concept</th>
<th>Version Specific</th>
<th>UML Concept</th>
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</tr>
<tr>
<td>Arbitrary</td>
<td>OOA96++ Type</td>
<td></td>
</tr>
<tr>
<td>Untyped Instance Handle</td>
<td>OOA92 Type</td>
<td></td>
</tr>
<tr>
<td><strong>Domain Specific Types</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constrained Base Type</td>
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<td>Type</td>
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<table>
<thead>
<tr>
<th><strong>Enumeration</strong></th>
<th><strong>Type</strong></th>
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<tbody>
<tr>
<td>Structure Set</td>
<td>OOA92</td>
</tr>
<tr>
<td>Typed Instance</td>
<td>OOA92</td>
</tr>
<tr>
<td>Handle</td>
<td>OOA92</td>
</tr>
<tr>
<td>Dynamic</td>
<td>OOA97</td>
</tr>
<tr>
<td>Deferred</td>
<td>OOA97</td>
</tr>
<tr>
<td>Units</td>
<td>OOA96++</td>
</tr>
<tr>
<td>Default Value</td>
<td>OOA96++</td>
</tr>
<tr>
<td>Range</td>
<td>Type</td>
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<tr>
<td>Precision</td>
<td>Type</td>
</tr>
<tr>
<td>Object Instance</td>
<td>Object</td>
</tr>
<tr>
<td>Relationship</td>
<td>Link</td>
</tr>
<tr>
<td>Instance</td>
<td>Link</td>
</tr>
<tr>
<td>Information</td>
<td>Stereotyped Class Diagram</td>
</tr>
<tr>
<td>Model Diagram</td>
<td></td>
</tr>
</tbody>
</table>

**State Modelling**

<table>
<thead>
<tr>
<th><strong>Instance State Model</strong></th>
<th><strong>Assigner State Model</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constrained State Machine associated with Class</td>
<td>OOA91 Constrained State Machine associated with Class</td>
</tr>
<tr>
<td>OOA96 Constrained State Machine associated with Class and Association</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>State</strong></th>
<th><strong>Event</strong></th>
<th><strong>Effects</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>Constrained Signal/Reception Pair. &quot;Event Direction&quot; maps to Reception is BehaviouralFeature is Feature is owned by classifier is class(model element), Tied to event on state machine by association with Signal Event</td>
<td></td>
</tr>
<tr>
<td>Transition</td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td>Cannot Happen</td>
<td>Transition associated with State by Internal Transition with Tag</td>
<td></td>
</tr>
<tr>
<td>Ignore</td>
<td>Transition associated with State by Internal Transition with Tag</td>
<td></td>
</tr>
<tr>
<td>Hold</td>
<td>Event associated by &quot;deferred event&quot; to state</td>
<td></td>
</tr>
<tr>
<td>Shouldn't Happen</td>
<td>OOA97 Transition associated with State by Internal Transition with Tag</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Non-existent State</strong></th>
<th><strong>Creation Event/State/Transition</strong></th>
<th><strong>Terminal State</strong></th>
<th><strong>Terminator</strong></th>
<th><strong>Event Parameter</strong></th>
<th><strong>Polymorphic Events</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>OOA92</td>
<td>Constrained Signal Event/State/Transition from Pseudo-State to the state</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constrained State that calls destroy event at end of entry action</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sterotyped Class, visible outside the package</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter on Signal Event</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polymorphic Events</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OOA92</td>
<td>Each &quot;event availability&quot; is an additional signal reception ultimately owned by the class for which is is available</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OOA96</td>
<td>Each &quot;OOA event&quot; alias is an additional signal &amp; reception &quot;raised&quot; by the aliased signal/reception pair</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Instance State Transition Diagram</strong></th>
<th><strong>Stereotyped State Chart</strong></th>
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<table>
<thead>
<tr>
<th>Assigner State Transition Diagram</th>
<th>Stereotyped State Chart</th>
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<tbody>
<tr>
<td>Instance State Transition Table</td>
<td>(Table)</td>
</tr>
<tr>
<td>Assigner State Transition Table</td>
<td>(Table)</td>
</tr>
<tr>
<td>Object Communication Model</td>
<td>Specification Level Collaboration Diagram</td>
</tr>
<tr>
<td>Thread of Control Chart</td>
<td>Sequence Diagram</td>
</tr>
</tbody>
</table>

**Synchronous Services**

<table>
<thead>
<tr>
<th>Service Parameters</th>
<th>OOA92</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Based Service</td>
<td>Operation owed by an interface class owned by the (domain)package</td>
</tr>
<tr>
<td>Object Based Service</td>
<td>Class based operation</td>
</tr>
<tr>
<td>Instance Based Service</td>
<td>Instance based operation</td>
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</tbody>
</table>

**Service Parameters**

<table>
<thead>
<tr>
<th>Service Parameters</th>
<th>OOA92</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>In Parameters</td>
</tr>
<tr>
<td>Output</td>
<td>Return Parameters</td>
</tr>
<tr>
<td>Polymorphic Service</td>
<td>OOA92</td>
</tr>
<tr>
<td>IsPolymorphic Operation with methods at each subclass</td>
<td></td>
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**Object Access Model**

<table>
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<tr>
<th>TBD</th>
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</table>

**Supplementary**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>OOA92</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario Schedule</td>
<td>Operation/Method of class in an initialisation subpackage belonging to domain package</td>
</tr>
<tr>
<td>External</td>
<td>OOA92</td>
</tr>
<tr>
<td>External List</td>
<td>Operation/Method of class in an initialisation subpackage belonging to domain package</td>
</tr>
<tr>
<td>Exception Handler</td>
<td>OOA92</td>
</tr>
<tr>
<td>Raising Exceptions</td>
<td>TBD</td>
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</table>

**RD & Bridges**

<table>
<thead>
<tr>
<th>Domain etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
</tr>
<tr>
<td>Dependency</td>
</tr>
<tr>
<td>Build Set</td>
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</table>
packages that it uses

<table>
<thead>
<tr>
<th>Domain Chart</th>
<th>Package Diagram</th>
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**Contracts**

<table>
<thead>
<tr>
<th>Contract</th>
<th>N/A</th>
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<tbody>
<tr>
<td>Contract Type</td>
<td>N/A</td>
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<tr>
<td>Closure Service</td>
<td>Signal or Operation</td>
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**Bridges**

<table>
<thead>
<tr>
<th>Terminator Service</th>
<th>OOA92</th>
<th>Operation on Stereotyped Class</th>
</tr>
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<tbody>
<tr>
<td>Untyped IH/Transfer Vector</td>
<td>OOA96++/OOA97</td>
<td>Parameters on the operation</td>
</tr>
<tr>
<td>ASL Mapping/Bridge Table</td>
<td>OOA97</td>
<td>Method provided by class in the build set package</td>
</tr>
<tr>
<td>Peer-to-Peer Counterpart Relationship</td>
<td>OOA97</td>
<td>association between terminator classes in imported domain packages</td>
</tr>
<tr>
<td>Specific/Generic Relationship</td>
<td>OOA97</td>
<td>generalisation between SCT and specific classes in imported domain packages</td>
</tr>
<tr>
<td>Explicit S/G CP Mapping</td>
<td>OOA97</td>
<td>Stereotyped method provided by the SCT class which raises the specific class operation</td>
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</table>

**Implicit S/G CP Mappings**

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<tr>
<th>Event Consumption</th>
<th>OOA97</th>
<th>Action on transition</th>
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<tbody>
<tr>
<td>Pre-State</td>
<td>OOA97</td>
<td>Addition to entry action</td>
</tr>
<tr>
<td>Post-State</td>
<td>OOA97</td>
<td>Addition to end of entry action</td>
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<tr>
<td>Pre-Service</td>
<td>OOA97</td>
<td>Additional method with pre-appendage</td>
</tr>
<tr>
<td>Post-Service</td>
<td>OOA97</td>
<td>Additional method with post-appendage</td>
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<tr>
<td>Attribute Access</td>
<td>OOA97</td>
<td>TBD</td>
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**Architectures**

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<thead>
<tr>
<th>Tag Group</th>
<th>Tag</th>
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<tbody>
<tr>
<td>Tag(Colour)</td>
<td>Tag</td>
</tr>
<tr>
<td>Tag Attachment (Colourisation)</td>
<td>Application of Tag (Tag Value)</td>
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**Miscellaneous**

**Subsystems**

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<tr>
<th>Subsystem</th>
<th>Package</th>
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<tbody>
<tr>
<td>Foreign Object</td>
<td>Imported Class</td>
</tr>
<tr>
<td>Foreign Relationship</td>
<td>Association belonging to imported class</td>
</tr>
<tr>
<td>Subsystem Relationship Model</td>
<td>Stereotyped Package Diagram</td>
</tr>
<tr>
<td>Subsystem Communication</td>
<td>Stereotyped Package Diagram</td>
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</table>
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