Visual Modeling and Transformation System

Visual Modeling and Transformation System (VMTS) is an n-layer metamodeling environment which supports editing models according to their metamodels, and allows specifying Object Constraint Language (OCL) constraints. Models are formalized as directed, labeled graphs. VMTS uses a simplified class diagram for its root metamodel ("visual vocabulary").
Also, VMTS is a model transformation system, which transforms models using graph rewriting techniques. Moreover, the tool facilitates the verification of the constraints specified in the transformation step during the model transformation process.

In VMTS, LHS and RHS of the transformation steps are built from metamodel elements. This means that an instantiation of LHS must be found in the host graph instead of the isomorphic subgraph of LHS. Both sides of the transformation step use formalism similar to that of the UML class diagram. The same instantiation rules apply to the LHS as to the UML class diagram, with two exceptions. (i) An association with the multiplicity * matches all the edges of the appropriate type in a given position. (ii) A type can appear more than once in the rules.
Rewriting rules can be made more relevant to software engineering models if the metamodel-based specification of the transformations allows assigning OCL constraints to the individual transformation steps. This technique facilitates a natural representation for multiplicities, multi-objects and assignments of OCL constraints to the rules with syntax close to the UML notation.
VMTS facilitates a refined description of the transformation steps. When the transformation is performed, the changes are specified by the RHS and *internal causality* relationships defined between the LHS and the RHS elements of a transformation step. Internal causalities can express the modification or removal of an LHS element, and the creation of an RHS element. XSLT scripts can access the attributes of the objects matched to the LHS elements, and produce a set of attributes for the RHS element to which the causality points. Therefore, it is not true that if a rule element appearing in the LHS but not in RHS is going to be deleted.
Classical graph grammars apply any production that is feasible. This technique is appropriate for generating and matching languages but model-to-model transformations often need to follow an algorithm that requires a stricter control over the execution sequence of the steps, with the additional benefit of making the implementation more efficient.
The VMTS approach is a visual approach and it also uses graphical notation for control flow: stereotyped UML activity diagram. VMTS Visual Control Flow Language (VCFL) is a visual language for controlled graph rewriting and transformation, which supports the following constructs: sequencing transformation steps, branching with OCL constraints, hierarchical steps, parallel execution of the steps, and iteration.
In VCFL, if a transformation step fails and the next element in the control flow is a decision object, then it can provide the next branch based on the OCL statements and the value of the *SystemLastRuleSucceed* variable. If no decisions can be found, the control is transferred to the parent state, if there is no parent state, the transformation terminates with error.
VMTS transformation steps have two specific attributes: *Exhaustive* and *MultipleMatch*. Applying a model transformation step means finding a match of LHS in the host model and replacing this subgraph with RHS. An *exhaustive* transformation step is executed continuously, as long as LHS of the step could be matched to the host model. The *MultipleMatch* attribute of a step allows that the matching process finds not only one but all occurrence of LHS in the host model, and the replacement is executed on all the found places.

The interface of the transformation steps allows the output of one step to be the input of another step (parameter passing), in a dataflow-like manner. This is used to sequence expression execution. In VCFL, this construction is referred to as *external causality*. An external causality creates a linkage between a node contained by RHS of the step *i* and a node contained by LHS of the step *i+1*. This feature accelerates the matching and reduces the complexity, because step *i* provides partial match to step *i+1*.

Compared to other approaches, VMTS meets the expectations in model-to-model and model-to-code transformation. VMTS has state of the art mechanisms for validated model transformation, constraint management and control flow definition. The environment has several standalone algorithms and other solutions that make them efficient.