Integrating Fuzzy Mde- AT Framework For Urban Traffic Simulation

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Abstract

This paper focuses on modeling of Urban Traffic System using Model Driven Engineering (MDE) and Activity Theory (AT) concept. It highlights the relationship between MDE and A.T. generating a notational framework. This framework is added with the Cartesian Fuzzy set measures and quantifies the uncertainty in modeling Urban Traffic System.

Keywords: Fuzzy - MDE, MDE-AT Framework, Urban Traffic System (UTS).

1. INTRODUCTION

Software Modeling plays an important role in order to develop better usability and understandability of the system. This paper advocates the use of Model Driven Language and Activity oriented Modeling. This Activity Oriented Model is derived from the basics of Activity Theory philosophy. Activity Theory is a philosophical conceptual and analytical framework to study human practices.

Activity Theory have their origins from Vygotskyian concept of tool mediation and Leontev's notion of Activity. Vygotsky's explanation of his concept tool mediation encompasses both physical and psychological tools namely : signs and symbols. The notion of tool mediation is central to Vygotsky's theory because tool allow human to interact more effectively with objects. Later on Vygotsky's model was refined and expanded by A.N. Leontev and Engestrom. They developed a final model which represents both the collaboration and Collective nature of human activity. The model developed is known as "Activity Triangle Model" incorporating components like : Subjects, Object, Community, Tools, Rules and Division of Labour.

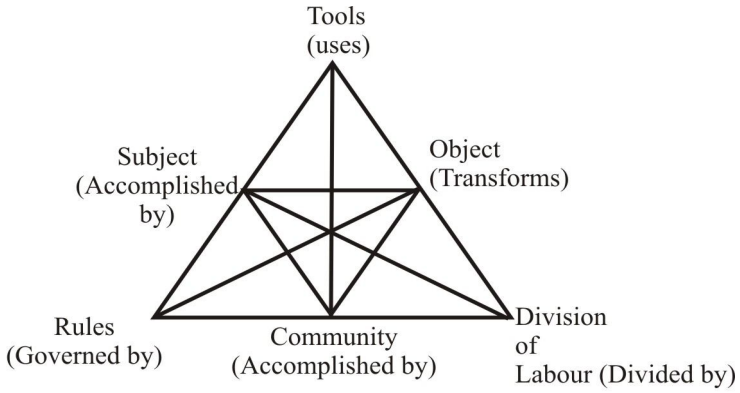

FIGURE 1: Activity Triangle

The "object" component portrays the purposeful nature of human activity, which allows individual to control their own motives and behaviour when carrying out activity.

The "subject" component of the model portrays both the individual and collective nature of human activity through the use of tools in a social context.

The "Tool" component of the model reflects the mediational aspects of human activity through the use of both physical and psychological tools. Psychological tools are used to influence behaviour in one way or another.

The "Community" component represents stakeholders in a particulars activity or those who share the same overall objectives of an activity.

The "Rules" components highlights the fact that within a community of actors, there are bound to rules and regulations that effect in one way or another means by which the activity is carried out.

The "Division of Labour" component reflects the allocation of responsibility and variations in job roles and responsibilities amongst subjects involved in carrying out a particular activity within a community.

The "Activity System" consists of several sub-activities that are interconnected and united through the shared objective in which activity is focused.

Overall the structure of Activity is defined as : "An activity pattern is a three- part rule which establishes a relationship between a context; a contradiction that arises in that context and its resolution, which takes it from its current state to a more developed one".

Model Driven Engineering successively refines models from analysis to design and then automatically generates code.

A common pattern in MDA development is to define a platform- independent model of a distributed application and to apply (parameterized) transformations to PIM to obtain one or more platform specific models (PSMs). When pursuing platform - independence one could strive for PIMs, that are neutral with respect to all different classes of middle ware platforms.

We will be using the concept of abstract platform which provides effective methods of exchange of signals between various modeling agents.

MDE supports both behavioural and structural aspects of a system so fuzzy MDE concepts are propounded in the present study as : Fuzzy structure and Fuzzy Behaviour
The use of Fuzzy with MDE covers the General Activity Diagram linked with Urban Traffic System. The Table - I represents various parameters in which we can correspond the A.T. concepts.

S.NO.	A.T. Terminology	Traffic Agents
1.	Activity	Set of Modeling elements of Urban Traffic Activity
2.	Subject	Urban Traffic System
3.	Objects	Traffic Movements, Road Network
4.	Outcome	Smooth Flow of Traffic/ Traffic Information
5.	Objective	Real Time Traffic Movement Control
6.	Tool	Resource such as S/W and H/W Platforms
7.	Community	Traffic Police Departments / Stake Holders
8.	Rules	Information Processing Rules
9.	Division of Labour	Workflow Design which will help in
10	Artifact	Elements of Urban Traffic Simulation & Control

Table I : Mapping A.T. with MDE with Special reference to urban Traffic System.

From this we can have a simple AT- MDE flow Diagram starting from Modeling of Urban Traffic System to the Tool used to achieve it.

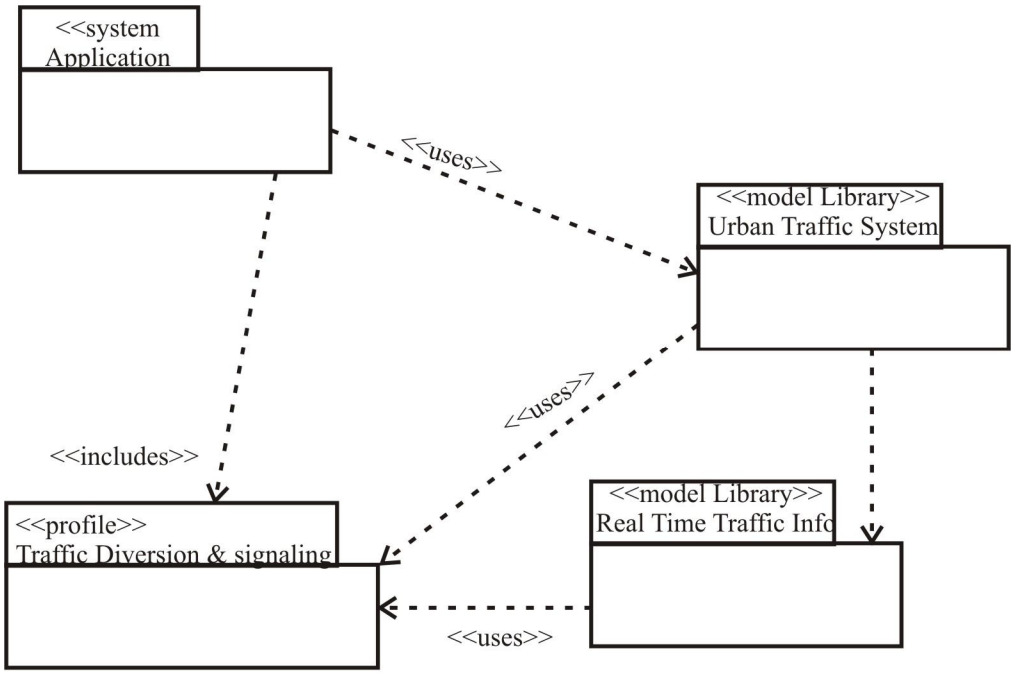

FIGURE 2 : MDE representation of Platform Independent Modeling

The MDE Abstract platform consists of Model Library packages which can be imported by the PIM of the application information technology.

2. THE MODEL

An abstract platform can have an arbitrarily complex behaviour and structure, varying from a simple one-way message passing mechanisms to a communication system that maintain a log book entry of sequence of operations.

In order to incorporate both the methodologies we specify the Platform Independent Model of a simple urban Traffic Control System, it is represent in UML 2.0 of MDE framework to combine A.T. with MDE.

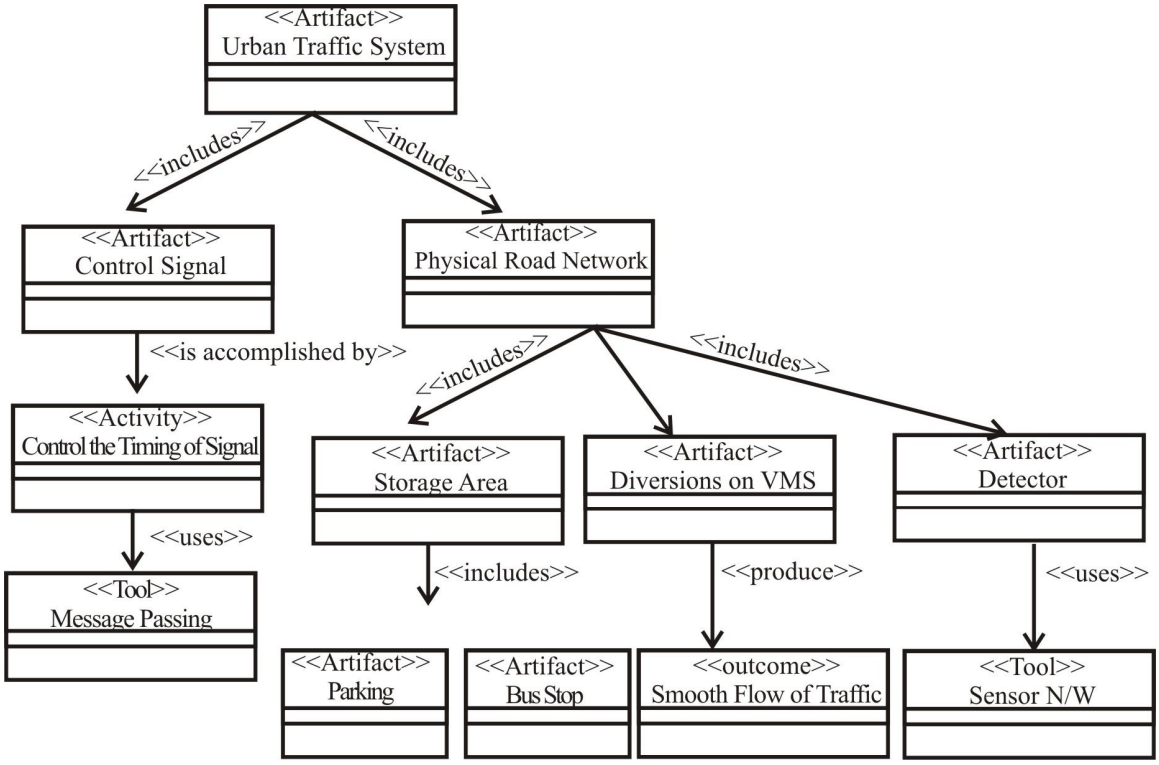

FIGURE 3. Generalised A.T. Framework

In order to elaborate further we discuss various components in detail.

Traffic Diversion and Signaling :

Figure 4 refers to Traffic Signaling scheme that relates to control aspect of Urban Traffic based on the traffic condition, the Control and Timing Signal meta-class.

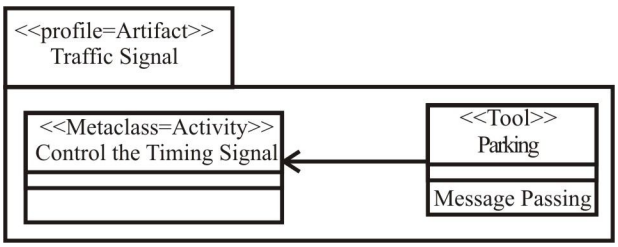

FIGURE 4: MDE-AT profile for the Artifact Traffic Signaling

gets activated which is related to activity theory and the type of signal control reaching to the various crossing are defined through Message Passing. Message Passing is done by the help of <<Tool>> (i.e. Networking Device).

Physical Road Network:
Physical Road Network consists of all the activity, which is done for smooth flow of traffic. It consists of three Meta-class diversions on VMS, which is an Interface in terms of MDE and an Artifact in A.T. semantics. Storage Area also forms a part of the physical Network.

It is connected by Parking and Bus Stop Detector which forms one of the <<interface>> shown as <<Artifacts>>, connected to a <<Tool>> named Sensor N/W, providing necessary inbound and outbound signals, hence placed in <<Signal>>. The behavioural pattern is shown in the Figure 5.

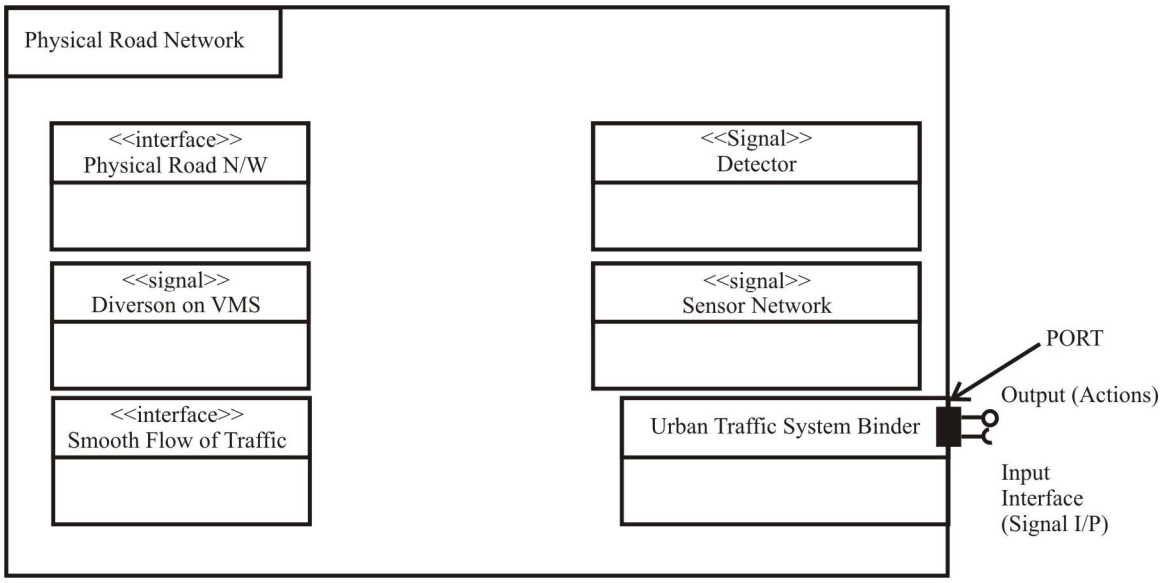

FIGURE 5: Physical Road Network Abstract Platform

FUZZY CONSTRAINT OF ABSTRACT URBAN TRAFFIC SYSTEM (UTS)

Figure 6 depicts the final realization of Abstract Urban Traffic system using Fuzzy Logic. The interaction point that corresponds to Port- 1 exchanges the signal received from the detector network and accordingly sends the control signal for various junctions and VMS.

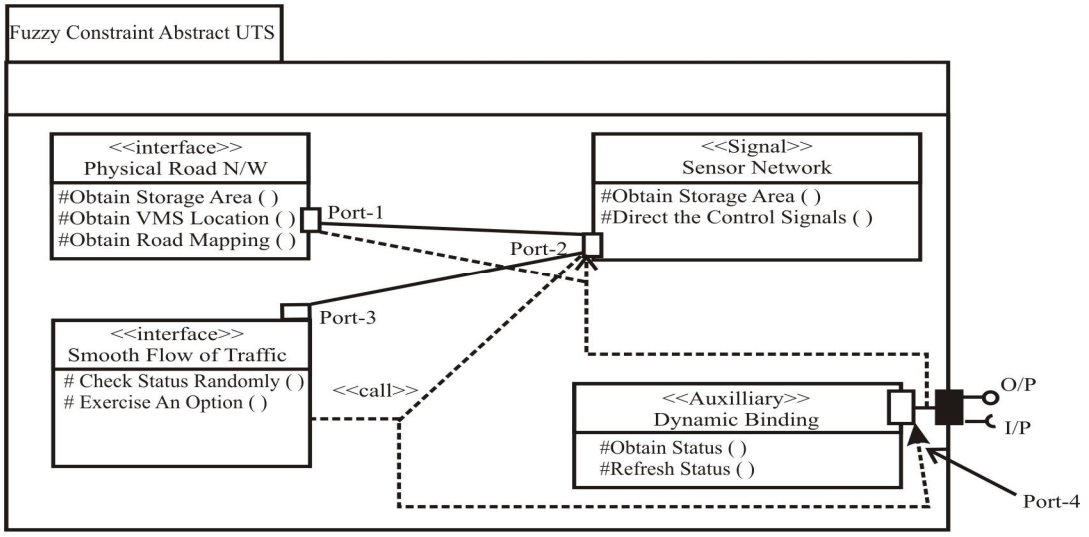

FIGURE 6: Fuzzy Platform Independent Modeling

In order to represent the Fuzzy PIM we use Linguistic Variables and Fuzzy rules for entering the uncertainty into the performance computations. The Fuzzy rule will be based on Activity Theory notation given by Linguistic description set

$$A.T. = \left\{ \begin{array}{lll} \frac{include}{Artifact} & \frac{uses}{Tool} & \frac{produce}{Outcome} \\ \frac{persue}{Objective} & \frac{transform}{Object} & \frac{divided\ by}{Division\ of\ Labour} \\ \frac{accomplished\ by}{Community} & \frac{Governed\ by}{Rules} & \frac{accomplished\ by}{subject} \end{array} \right\}$$

We will now implement Fuzzy Relationship within various port of elements of Fuzzy PIM Abstract Platform.

The fuzzy relation is a fuzzy set defined on the Cartesian product of elements. {X, X2, ...Xn} where types (x1, x2.....xn) may have varying degree of membership $\mu R\ (x_1,x_2,.....x_n) = \int \mu R\ ((x_1,x_2,.....x_n)$

Applying the above Cartesian Rule to A.T-MDE framework. We start with the elements R (Physical Road N/W, Sensor Network, Smooth Flow of Traffic, Dynamic binding).

$= \int \mu R$ (obtain Storage Area (), Obtain VMS (), Obtain Road Mapping ( ) , Obtain Sensor Signal ( ) .....).

Let $\overset{X}{\sim}$ = {Obtain Storage Area ( ), Obtain VMS ( ), Obtain Road Mapping ( ),
Obtain Sensor Signal ( ) .....}

$\overset{Y}{\sim}$ =

$$\left\{ \frac{\text{include}}{\text{Artifact}} \quad \frac{\text{uses}}{\text{Tool}} \quad \frac{\text{produce}}{\text{Outcome}} \right.$$

$$\left. \frac{\text{persue}}{\text{Objective}} \quad \frac{\text{transform}}{\text{Object}} \quad \cdots\cdots \quad \frac{\text{accomplished by}}{\text{subject}} \right\}$$

Fuzzy Relationship R (X, Y) can be expressed by n_{xm} matrix as follows :

$\underset{\sim}{R}(\underset{\sim}{X}\ \underset{\sim}{Y}) \rightarrow$

	include / Artifact	uses / Tool	produce / Outcome	persue / Objective	transform / Object	..... accomplished by / subject
Physical Road N/W	Obtain Road Mapping ( )	Obtain Storage Area ( )				Obtain Road Mapping
Sensor Network	Obtain Sensor Signal ( )			Direct the Storage Area ( )		
Smooth Flow of Traffic	Check Status ( )	Direct the Conrol Signals ( )				Exercise An Option ( )
Dynamic Binding	Obtain Status ( )	.				

The R relationship finally can be stated as:

$$\underset{\sim}{R} = \frac{\text{Obtain Road Mapping ( )}}{\text{Physical Road N/W, } \underset{\text{Tool}}{\underline{\text{Uses}}}} + \frac{\text{Obtain Storage Area ( )}}{\text{Physical Road N/W, } \underset{\text{Objective}}{\underline{\text{Persue}}}} + \frac{\text{Obtain Road Mapping ( )}}{\text{Physical Road N/W, } \underset{\text{Objective}}{\underline{\text{Persue}}}}$$

$$+ \frac{\text{Obtain Sensor Signal ( )}}{\text{Sensor N/W, } \underset{\text{Tool}}{\underline{\text{Uses}}}} + \frac{\text{Direct the Control Signal ( )}}{\text{Sensor N/W, } \underset{\text{Object}}{\underline{\text{Transform}}}} + \ldots\ldots$$

$$+ \ldots\ldots \frac{\text{Exercise an Option ( )}}{\text{Dynamic Binding Accomplished by}}$$

Relationships between objects are the concepts involved in dynamic system applications. The Classical binary relation represents the presence or absence of connection or absence of a connection or interaction or association between Model Driven Engineering Concepts and Activity Theory (A.T.) framework with reference to Urban Traffic System (UTS).

3. CONSLUSION & FUTURE SCOPE

This paper presents a framework aimed to facilitate the modeling of Urban Traffic System. It focuses on the method engineering approach for systematic modeling of a system. The use of Activity Theory (AT) provides sociological intentions of modeling a system. The help of relationship link of Fuzzy Set theory achieves the mapping of various entities of Abstract Model. The existence of uncertainty in message passing and control between different entities is evaluated by Cartesian framework.

The future development will be to incorporate Stochastic Algebra into the framework for necessary constraint checks on the Fuzzy relationships.

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