Journal of Theoretical and Applied Information Technology
30th September 2012. Vol. 43 No.2

ISSN: **1992-8645** www.jatit.org E-ISSN: **1817-3195**

PROBLEM FRAMES ANALYSIS OVER SysML MODEL FOR CRITICAL GOODS TRANSPORTATION MONITORING SYSTEM

[1]BHUVANESHWARI S, [2]VAIDEKI K J, [3]KUMAR K, [4]MARGRET ANOUNCIA S

[1, 2] Cognizant Technology Solutions Pvt Ltd., Chennai.

[3,4]School of Computing Science and Engineering, VIT University,Vellore-14

E-mail: [1]bhuvaneshwari.vit@gmail.com, [2]vaideki.kj@gmail.com, [3] kkumar@vit.ac.in
[4]smargretanouncia@vit.ac.in,

ABSTRACT

The best way to approach requirements analysis is a process of parallel analysis. The designing of any software system starts from its scratch of requirement analysis because requirements are building blocks of a system. SysML tool is the System Modelling Language tool used for the graphical representation of the requirements using Requirements Diagram. Requirements given by the user are the relationships in the real world and application domains but not about the software system or the interface with the software system. These are the basic philosophies of problem frames (PF) approach which is a requirement analysis technique. Here in this paper we discuss about the SysML tool usage on the problem domain given to the analyser and the application of PF approach in decomposing and analysing the requirements to develop the requirements statement which will be given to the design phase to be recursively analysed and the system will be developed. The paper deals with the above mentioned approach to the modelling of requirements of the Critical Goods Transportation Monitoring System that proves to be the best analysis technique of requirements for the mentioned system so far.

Keywords: *Requirement Analysis, Problem Frames, Sysml, Requirement Diagram, Problem Diagram*

1. INTRODUCTION

The Problem Frames approach is a requirements analysis technique that is gaining more and more attention in both academic and industry. The reason of this interest is because Problem Frames help developers analyzing problems through problem comprehension and description [1]. Also Problem Frames have the potential of improving the early phases of software development processes. SysML is the extension of subset of Unified Modeling Language. It is an open source specification which supports specification analysis, design, verification and validation of wide systems [2]. Here in this paper the problem domain will be given to the analyzer and the domain will be subjected to low level classification applying SysML tool to come up with the requirement diagram. With that decomposition and analysis of requirement will be represented by problem diagrams by using problem frames approach.

Requirements analysis using Problem Frames approach clearly differentiates between solution and problem space. Here the solution gives the specification of the software system as a "machine" which is connected to the outside world requirement. This world represents the problem space, and is composed of domains that interact with the machine through shared phenomena. The machine will give a solution since it is part of this world and it is connected to problem domains. Problems are modeled in terms of domains, their shared phenomena and a set of user requirements. Problem Frames clearly says that user requirements express relationships among elements of problem space. Once the requirements are analyzed then those requirements are recomposed to the main domain and given to the design phase. The approach drives the analyst from the phase of problem description, where the characteristics of the problem and its requirements are defined, to the specification of the machine that satisfies the requirements [3, 4].

2. METHODOLOGY

The method adopted in this paper is given stepwise in Fig 1. In step 1, the Problem domain is given to the analyzer, then in step 2 the

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SysML based requirement diagram is developed, with these broad categorization of requirements proceed with step 3 as applying PF approach to decompose, analyze and recompose the requirements [5]. In step 4 the recursively analyzed requirements are given to design phase, from there to development in step 5 so that to get unambiguous requirement to develop the system effective with least cost.

Step 1: Problem domain is given to the analyzer

As the proposed method starts form problem domain, the problem domain is given to the analyzer to precede the process analyzing of requirements for that problem domain to develop the software system efficiently.

Step 2: Model representation using SysML tool through Requirement diagram

SysML enables and Supports the specification, analysis, design, verification, and validation of systems with hardware, software, data, personnel, procedures, and facilities. SysML stencil tool supports to develop the requirement diagram which provides broad category of the given domain considering the requirement's priority [2]. As mentioned in the Fig 2 the requirement will be described with the contents.

Step 3: Decompose the problem domain and requirement analysis with PF approach

When the whole Problem domain is considered an analyzer cannot come up with all the necessary requirements, it may lead to miss the major requirements. So decomposing the problem domain with PF approach is to identify all required requirements easily and avoid redundancy of requirements. A problem frame is a kind of pattern.

Solving a problem domain using PF approach is done by constructing a 'machine' and integrating it into the domain whose behavior is to be analyzed.

For each problem frame a diagram is set up with plain rectangles denote application domains, rectangles with a double vertical stripe denote the machine domains to be developed, and requirements are denoted with a dashed oval. They are linked by lines that represent interfaces called shared phenomena Fig 3 [6]. Many number of problem frames created for the problem domain then these PFs are given to step 4 as input for developing.

Let us assume the problem domain as D, requirements as {R1, R2, R3,… Rn}, developed model as M and frames as F.
Our derivation is:
For a domain D, $D \rightarrow M$

$(R1 v R2 v R3 v \ldots v Rn) \rightarrow M$

$M \rightarrow F$

$D \rightarrow F$

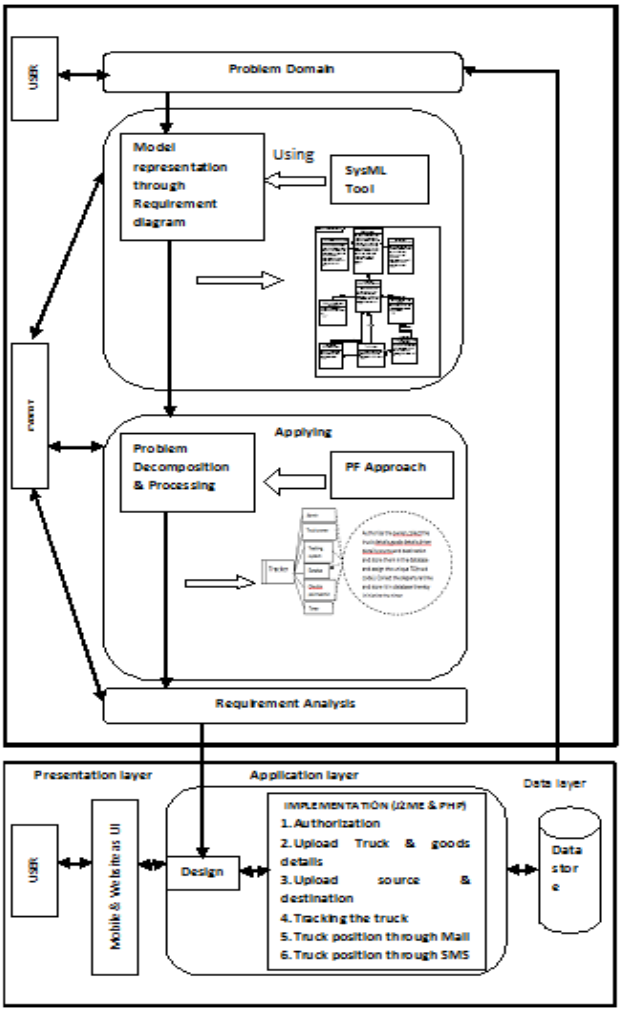

Figure 1: Overview of methodology

Step 4: Recursively analyzed requirements are given for design

The requirements from all the problem diagrams are recomposed and given as requirements statement to the analyzer and then to the design phase. Here the system is designed with their modules and checked for the

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satisfaction of the requirements of the system. If the system does not meet the required requirements then it will be analyzed again with the PF approach to come up with the refined requirements statement for designing.

Step 5: Development of the system

Once the design is made the development team will proceed with the system development with the programming languages probably J2ME, PHP or any other. Here the modules of the system are clearly analyzed and developed to meet the requirements exactly.

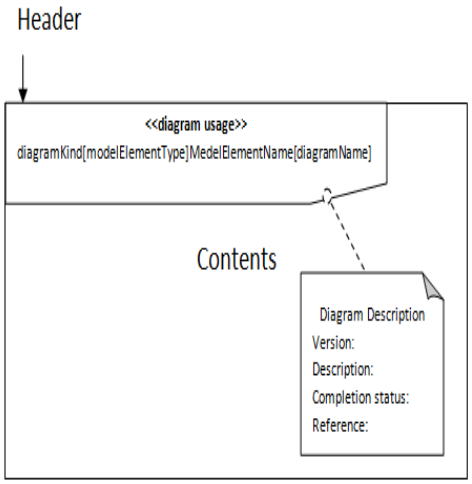

Figure 2: General format of Requirement Diagram

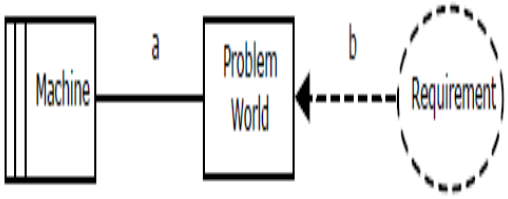

Figure 3: Generalized Problem Diagram

3. EXAMPLE CASE STUDY

To verify the validity of the proposed approach, it is applied to Critical Goods Transportation Monitoring System which allows the admin/ Transport owner to access and upload the details about the material that is transported by the vehicle. And also allows to check at check points and upload the truck's arrival time at every check point. Finally it reports the truck owner whether the truck is reached the destination at scheduled time or it delayed and whether the material transported is in good condition or not, through mail/sms or graphical representation and also stores in dataset. Where the truck can transport critical dangerous and non-dangerous goods. Using the stored data, in future we can analyze in which root the goods are transported fast and safe.

Step 1:

The problem domain is given as Critical Goods Transportation Monitoring System to the analyzer to analyze the requirements of unambiguous and derive the specification from the requirement and will be given to the development phase.

Step 2:

The requirement of the case study Critical Goods Transportation Monitoring System is drawn using SysML tool to understand and frame the requirements in clear picture. Here the first step in Fig 4 is of categorizing goods with low priority and high priority of critical and non-critical goods based on the state, transportation path and the importer of the goods. In the next state of the diagram the tracking function of the system is figured with the availability of goods, truck malfunctioning, auditing the truck state in the check-in points, safety arrival of the truck to the destination and track reporter their functionalities to be satisfied. For example the first block represents the "problem context" which describes the whole problem domain precisely. And in the next level the priority of the goods transported is drawn. Proceeded with the next level it represents the goods malfunctioning, track state auditing and report submission of tracking. Now this requirement diagram gives clear picture about the CGTS system in broad classification. This makes the analyzer easier to phrase the requirements.

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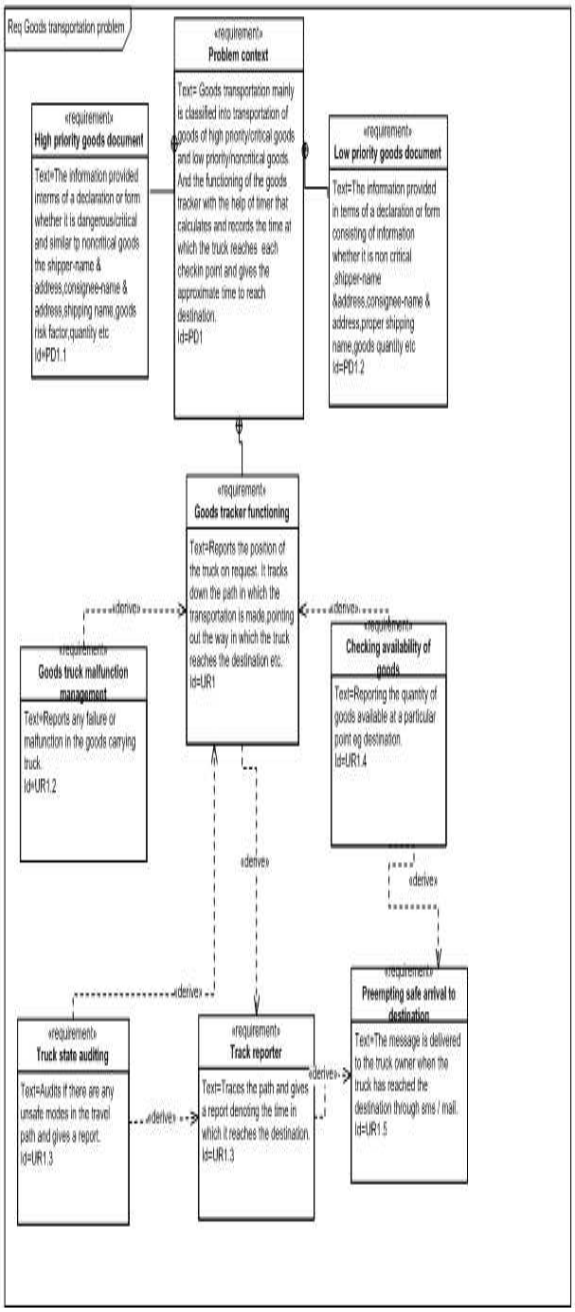

Figure 4: SysML Model for CGTMS system.

Step 3:

There are the possible problem frames analyzed for the Critical Goods Transportation Monitoring System. These Problem diagrams describe the individual pattern of the case study taken. The first diagram Fig 5 represents the "authorization" module which is decomposed from the main domain and analyzed the requirements of the module. It clearly says the application domain as data storage and the machine required is the CGTS system and the requirement is clearly mentioned that "authorize the user with provided data". The same way the other Problem diagrams as given by the experts, represents the requirements of remaining module of the system elegantly.

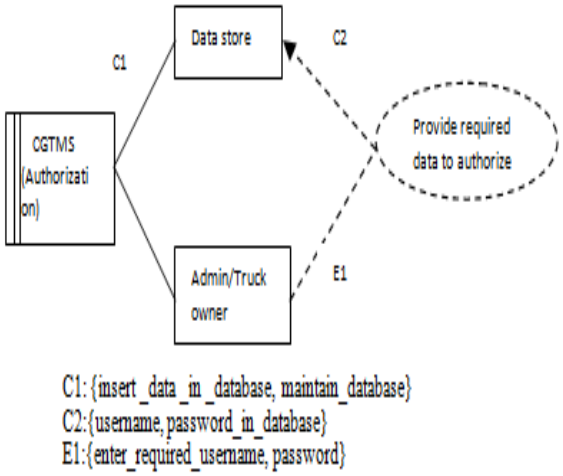

Figure 5: Authorization

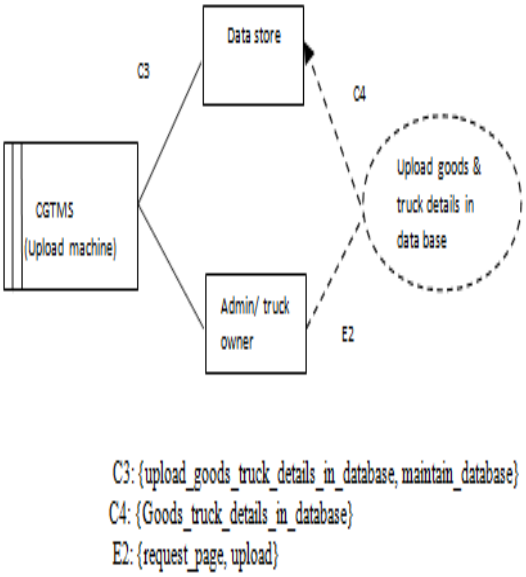

Figure 6: Upload goods and truck details

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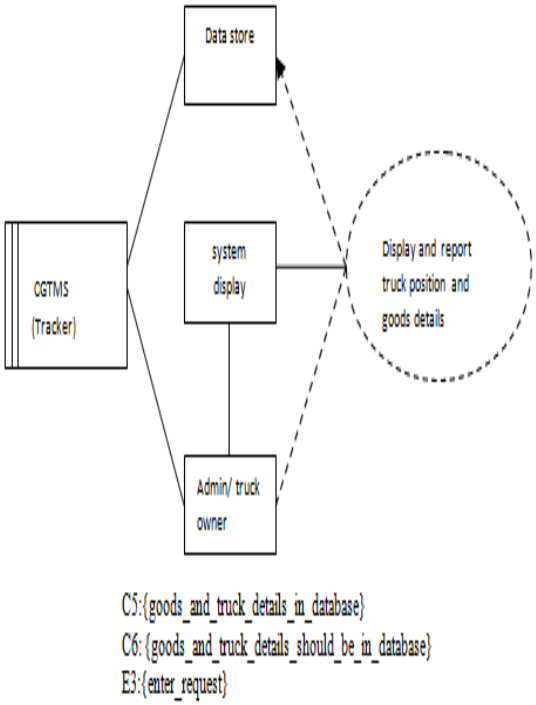

Figure 7: Report truck position

Step 4:

From the above problem diagrams the analyzer will clearly know the requirements for the system. So with the requirements the system will be designed with its modules and functions. Here the CGTMS system will have the Authorization, Upload Goods and Truck details, tracking truck and report the truck position as the modules.

Step 5:

As processed in the above four steps, we follow the design to develop the CGTMS system which allows to monitor the road transport in all situations, using PHP/J2ME. Here PHP is used to design the website of CGTMS to the use of office admin. And J2ME is used to develop the mobile application which will make easy access of the system when the admin/ truck owner to upload details and receive the transport report through sms or mail. In the following figures the development of the system is pictured.

Figure 8: Website for CGTMS system

Here this is the website of CGTMS system which has the login followed by uploading and monitoring the goods transportation.

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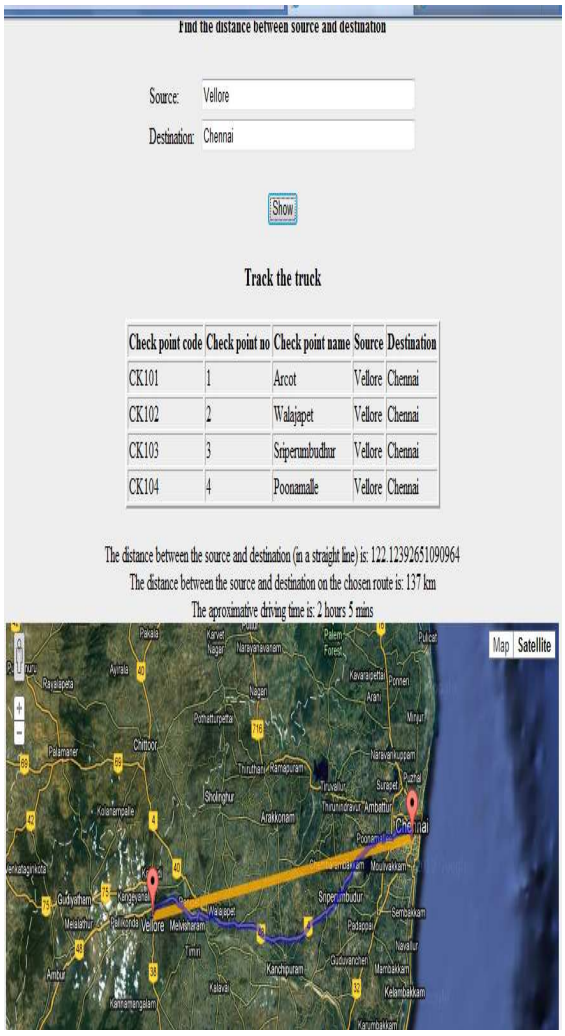

Figure 9: The graphical display of CGTMS system

Here in this snapshot of the system represents the output display of the monitoring system. Here it displays the source and destination as Vellore to Chennai and the check-in points crossed in between them and the graphical display.

4. RELATED WORK

Problem solving is central focus of math, science and engineering domains. Our long-term goal is to fit RA within the larger and better scholarly problem analysis and system development [7]. One of the modeling language SysML stencil tools allows framing a model for the problem and making easy understanding of the system requirements broadly. PF approach is to create representations for broad problems in software engineering. It pushes the state of Requirement engineering forward by trying to analyze the broad problem domain into smaller application domains and analyzing them. Due to the dynamic of contemporary software, models need to be more flexible and with richer semantics. Researchers work on formalizing, extending and practicing the concepts in PF. One of the key benefits of problem frames is that it pushes the analyzer to be clear about what assumptions are being made by decomposing of end-to-end requirements into sub domains [8, 9].

Those assumptions can then be checked by domain expert. The monitoring system has its main requirement as safety measures. In our case the authorization and continuous monitoring of the transportation is considered. This leads the security primaries. In fact, finding whether two (or more) trucks are close to the spot is easy by the system. This work is compatible with few other approaches, which is targeted on the similar problems and the solutions.

5. FUTUREWORK

Future work includes applying the problem frames in more efficient as well as expanding the repository of requirements statements. Also, we plan to integrate this work in formalizing requirements that will enable us to analyze the requirements statements for various properties such as consistency within requirements [10]. We will use simulation to validate the behavior method of the requirements analysis. Our experience with the CGTMS case study leads to integrate the above provided process with less analyst involvement and more tool development for the method. The move from requirements specification to architectural design is one of the most difficult process in developing software system. Though requirements analysis and design different and difficult task, these processes are giving shape to the user required system. In future tracking can be made more realistic by monitoring the vehicle (truck) through GPS. The above are the some of the possible future enhancements that can be made. Here since we use PF approach it can be enhanced to pattern matching which will be helpful for similar kind of systems (reuse).

6. CONCLUSION

This paper describes PF approach to decompose and analyze the problem domain into sub problems. [11]. And with the problem analysis of

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each subtasks, proves each alternative design become motivation and supported with evidences [12]. PF approach has the potential to dramatically improve the early lifecycle phases(SDLC) of software projects by bringing benefits of easing the achievement of a fairly complete and clear comprehension of requirements in the early phases of the project.

The approach decomposes the problem domain given by the client and analysis each sub domain with three components machine, application domain and its related requirement, the recomposes the requirement to develop the system. The SysML tool is used to model the problem diagram from the given requirements. Based upon those consistent requirements the system is developed. Here the CGTS system is taken as a case study and analyzed the requirements and the system is developed. The main objective of the system is monitor the goods transportation on roads and has the security features also. The system is divided into modules and for each module the PF approach is used to analyze the requirements and the problem frames drawn for each requirement. Also the SysML tool is used to drive the problem context for this given domain to make clear picture of the necessary requirements without redundancy.

Then the GGTS system is developed using J2ME and PHP. The CGTS system can be accessed through mobile and website. The system will drive us to make a secured goods transportation in all way. The implementation of this system indicates the success of the PF approach analysis of requirements for this system.

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