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ARTICLE

SECURITY IN REQUIREMENTS AND DESIGN PHASES

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ABSTRACT

Objective: *The objective of the research is to integration security in the development process to develop secure software.* ***Method/Analysis:*** *The proposed methodology involves all stakeholders to rank their relevant entities over security parameters. Based on this ranking, diagrams are drawn that indicate the level of security desired. The diagrams are near to UML and easy to understand.* ***Findings:*** *Developing secure software is important in the light of increasing flow of sensitive information and different kinds of users interacting with the system. A good solution is to integrate security in the development process but there are several issues and constraints. There are a few existing techniques proposed to address this problem but these have one or the other limitations. There is lack of empirical analysis in this area of research and existing design languages are not efficient in presenting the security concerns. However, most researchers believe that early phases of requirement and design are the most appropriate for such integration.* ***Novelty/Improvement:*** *The suggested methodology involves all stakeholders in the process but with concept with empirical analysis, tightly coupled requirements and design phases, easier and effective diagrams, and concept of relevance.*

KEY WORDS
requirements engineering, modeling, functionality

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INTRODUCTION

Researchers [1,2] believe that development process is a major source of security problems in software and the solution lies in integrating security in the development process. The discussion presented in [3] reveals that such an integration in the first two phases of Software Development Life Cycle (SDLC) i.e. requirements and design, will be most appropriate. Requirement elicitation is considered critical and ambiguous [4] and necessity of security in this phase has been stressed. An ideal approach is to freeze requirements initially but it is not practical. Similarly, designing is essential for better communication between developer and client. In this regard Unified Modeling Language (UML) is quite prevalent but researchers do not find it suitable for modeling security requirements due to varied reasons [5, 6]. These issues have served as a motivation for the development of Security Requirements Elicitation, Assessment and Design (Sec READ) methodology. Several other software process models have been proposed earlier but all of them have certain limitations. These have been elaborated in Goel et al. [7, 8].

METHOD

Sec READ is a methodology that integrates of security in the software development life cycle. It is based on Assets (data items), functionalities and stakeholders. Sec READ is a well-structured process that first gathers requirements, then rates them on security parameters and finally, shows these ratings graphically in a meaningful way. It is kept in mind that only the relevant stakeholders rank the relevant assets and functionalities. The steps of this methodology are Identification, Refinement, Mapping, Ranking, Analysis and Design. [Fig. 1] depicts the process flow.

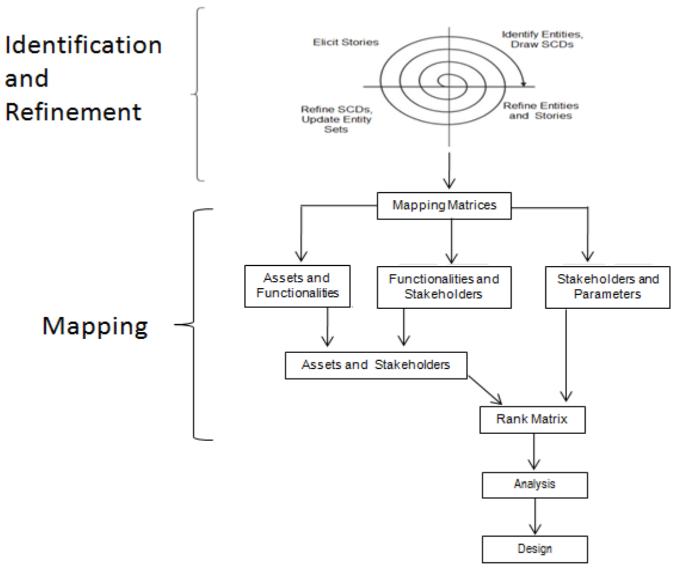

Fig. 1: Sec READ Methodology.

IDENTIFICATION & REFINEMENT

These two phases move spirally as seen in [Fig. 1]. The spiral activity is initiated by the representative(s) from the client and developer side and the expert group. After each spiral newer stakeholders, assets and functionalities are incremented, if any. The expert group includes the business experts and experienced technical people.

Stories and story conversion diagrams

The client and the users narrate the requirements to the expert group. These requirements are called 'Story' and can be in natural language. Once a story is elicited the assets, stakeholders and functionalities are identified and put into three sets i.e. S, A and F respectively.

$S = \{S1, S2,....Sn\}$, $A = \{A1,A2,......Am\}$ and $F = \{F1,F2,.......Fp\}$ $n \in W$, $m \in W$, $p \in W$

where, W is the set of whole numbers

A Story Conversion Diagram (SCD) is drawn for every story as and when it is elicited for graphical representation. There are different kinds of stories and each of them requires a different type of SCD. Stories may contain only one entity from stakeholder, asset or functionality. Other stories may contain two, three or multiple instances of entities. The SCD for a three-entity story is shown in [Fig. 2]. Here, $Si \in S$, $Aj \in A$ and $Fk \in F$.

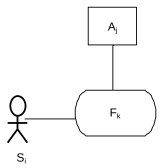

Fig. 2: Three entities.

Refinement of stories and SCDs

Up till now, the stories are elicited and converted as it is into SCDs. This information is refined by experts through the techniques of redundancy removal, and decomposition and aggregation. There may be more than one name (or similar names) for a single asset, functionality or stakeholder, which are removed. In the next cycle, the newly identified stakeholders sit together with the previous stakeholders to identify more entities. If new entities are not found, the process stops. When the spiral culminates sets for asset, stakeholder and functionality are formed. In this paper, for explanation, following sets are used.

$F = \{F1, F2, F3, F4\}$
$S = \{S1, S2, S3\}$
$A= \{A1, A2, A3, A4, A5\}$

MAPPING

Matrices

In this phase, the related entities are mapped through. The experts and the developers perform the mapping. These matrices are developed on the basis of the information collected. This process is performed by. The shaded cells in the matrices show relevance. Functionalities and assets mapped by matrix X shown in [Table 1]. Matrix Y [Table 2] maps stakeholders to functionalities. Matrix Z, shown in [Table 3], relates stakeholders to assets and is obtained by the multiplication of matrices X and Y.

$X = (x_{ij})$

where, $i = 1, 2, 3, ...a$
$j = 1, 2, 3, ...f$
$a = n(A)$, $f = n(F)$

$Y = (y_{ij})$

where, $i = 1, 2, 3, ...f$
$j = 1, 2, 3, ...s$
$f = n(F)$, $s = n(S)$

Table 1: Matrix X

F / A	F_1	F_2	F_3	F_4
A_1				
A_2				
A_3				
A_4				
A_5				

Table 2: Matrix Y

S / F	S_1	S_2	S_3
F_1			
F_2			
F_3			
F_4			

Z = (zij)

where, i = 1, 2, 3, ...a
j = 1, 2, 3, ...s
a = n(A), s = n(S)

Table 3: Matrix Z

S / A	S_1	S_2	S_3
A_1			
A_2			
A_3			
A_4			
A_5			

Parameters

The assets are to be ranked by the stakeholders on the confidentiality, authentication, integrity, non-repudiation and authorization parameters. P is set of parameters. Stakeholders are mapped to parameters based on their expertise or technical awareness. A stakeholder, thus, can rank assets on his/her relevant parameters only. Matrix W [Table 4] maps the two.

Table 4: Matrix W

P / S	Authentication	Integrity	Confidentiality	Non-repudiation	Authorization
S_1					
S_2					
S_3					

Rank matrix

R is a three dimensional matrix, developed using X, Y and Z. It has assets as rows, parameters as columns and stakeholders as depth or sheets. Every stakeholder has one version of the sheet on which he/she has to perform ranking.

R = (rijk)

Where, i = 1, 2, 3, ...a
j = 1, 2, 3, ...p
k = 1, 2, 3, ...s

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$a = n(A)$, $p = n(P)$, $s = n(S)$

RANKING

The applicable cells in the rank matrix are ranked as 1 (Low), 2 (Medium) and 3 (High) for the level of security desired. Always, the assets are ranked over authorization parameter by the core group only to avoid partiality. Goel et al. [9] describes elaborately how this parameter is dealt with and corresponding diagrams.

ANALYSIS

The final rank of the entities is calculated and diagrams are drawn. Taking matrix R, the mode of all values stored in the same cell in all the sheets is calculated and this consolidated value is stored in a matrix C. In this way a 2-dimensional matrix is obtained with assets as rows and parameters as columns. Now, using matrix C, for every row, mode of all values is calculated. These values serve as the consolidated asset rank. Similarly, consolidated parameter rank is obtained by calculating the modes of all columns. To find the rank of any functionality, the assets relevant to it only are considered as in matrix X [Table 1].

DESIGN

A rank diagram is drawn for every functionality of the system. [Fig. 3] is an example rank diagram for functionality F_4 as per matrices X, Y and Z. It shows that F_4 is a medium security functionality with two stakeholders S_1 and S_3. Three assets are associated with it. Security requirement for asset A_2 is low, for A_3 is medium and for A_5 is high. Ranks are denoted by concentric rectangles for assets and concentric ovals for functionality. [Fig. 4] summarizes the complete system.

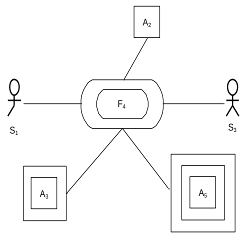

Fig. 3: Rank diagram for functionality F_4.

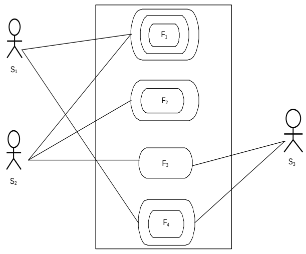

Fig. 4: System Rank Diagram.

CONCLUSION

The methodology is unique as it involves all stakeholders. Functionalities and assets are ranked by the stakeholders that are related to them only. The diagrams grow with the increasing information obtained. A single diagram illustrates a large amount of information in a manner which is simple to comprehend.

CONFLICT OF INTEREST
There is no conflict of interest.

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