Modelling of CWEs on the CWE-287 example

Zhanar Sartabanova[1], Vladimir Dimitrov[2]

[1] K. Zhubanov ARSU, 34 A. Moldagulova Prospect, 030000 Aktobe, Kazakhstan
zhanara.85@mail.ru
[2] University of Sofia, 5 James Bourchier Blvd., 1164 Sofia, Bulgaria
cht@fmi.uni-sofia.bg

Abstract. Representing of software weaknesses in a knowledge base is an approach to support software developers in their effort to write secure code. The leading idea of this research is to represent the knowledge in CWEs as knowledge in OWL.

Keywords: software weaknesses, CWE, knowledge base, OWL.

1 Introduction

The software systems are part of our everyday life. The vulnerability risk of these systems increases with the number of the users. The weaknesses can be exposed as vulnerabilities during the system exploitation, but they are introduced during the implementation phase. That is why it is so important to prevent software weaknesses during the implementation.

The developer's community established Mitre Corporation to create an international list of software weaknesses – CWE.

CWE (Common Weakness Enumeration - a common list of weaknesses) [1] is an international list of software weaknesses, which is freely available for public use. The use of this list ensures the creation of enhanced software, taking into account existing weaknesses.

Software weakness is any mistake made during the implementation, configuration, or design of the software. Software weakness is a defect, malfunction that if left uncorrected may be exposed as a system vulnerability for direct, or network attacks.

3 Construction of CWE-287 ontology

The common list of software weaknesses of CWE is a formal list of types of weaknesses that is created to aim the software developers and practitioners in the field of cybersecurity. CWE-287 is one of these enumerated weaknesses.

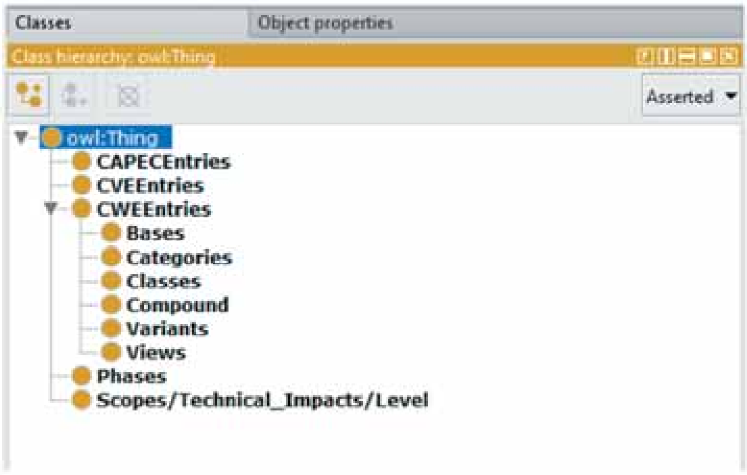
The knowledge contained as a text in CWE-287 is represented as OWL knowledge in Protégé.

Protégé is a free, open ontology editor and knowledge base building framework.

Protégé has an open, easily expandable architecture with support for modules that extend functionality.

Protégé is supported by a large community of developers and scientists, government and corporate users, who use it for knowledge - related tasks in such diverse fields as Biomedicine, knowledge gathering and corporate modeling. [2]

The class hierarchy of CWEs is shown in Fig 1.



owl:Thing
- CAPECEntries
- CVEEntries
- CWEEntries
  - Bases
  - Categories
  - Classes
  - Compound
  - Variants
  - Views
- Phases
- Scopes/Technical_Impacts/Level

Fig. 1 . CWEs class hierarchy.

CWE entries are Bases, Classes, Compound, and Variations.

The most abstract type of weakness is the Class. It is independent of any particular language or technology.

Base is a more specific type of weakness. It is still largely independent of the resource or technology, but contains enough details to have specific detection and prevention methods.

Variant is a weakness that is described at a very low level of details. It is usually limited to a particular language or technology.

Compound is a significant collection of several weaknesses, organized in a chain or in a composite.

All other CWEEntries represented in Fig. 1 describe the CWE environment.

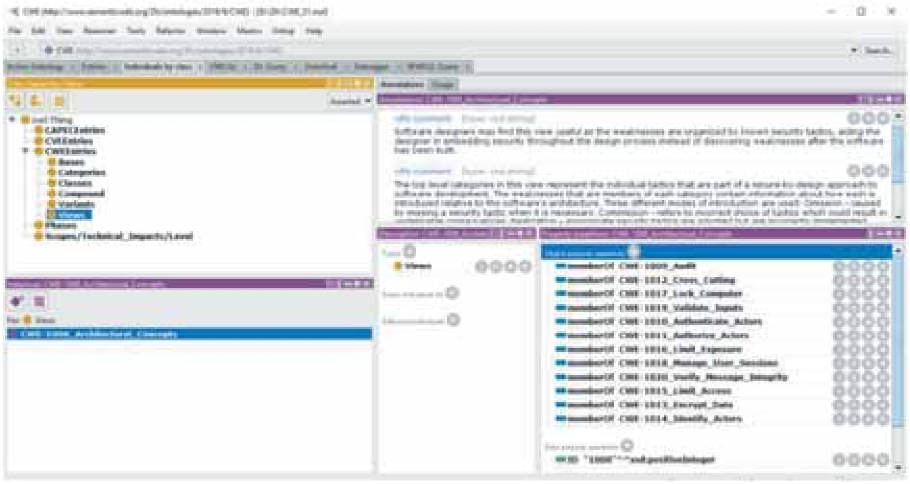
CWE entry “Views” represents a conceptual point of view to the CWEs. It is a set of other CWEEntries. A view can contains Categories at its higher level, but it is not obligatory.

Category is a CWE entry that contains a set of other entries that share a common characteristic.

In our case CWE-1008 VIEW: Architectural Concepts is used. It contains the following categories:

- Audit - (1009)
- Authenticate Actors - (1010)
- Authorize Actors - (1011)
- Cross Cutting - (1012)
- Encrypt Data - (1013)
- Identify Actors - (1014)
- Limit Access - (1015)
- Limit Exposure - (1016)
- Lock Computer - (1017)
- Manage User Sessions - (1018)
- Validate Inputs - (1019)
- Verify Message Integrity - (1020)

Fig. 2 represents this architectural hierarchy.



```
owl:Thing
    CAPECEntries
    CVEEntries
    CWEEntries
        Bases
        Categories
        Classes
        Compound
        Variants
        Views
    Phases
    Scopes/Technical_Impacts/Level
```

CWE-1008_Architectural_Concepts

Software designers may find this view useful as the weaknesses are organized by known security tactics, aiding the designer in embedding security throughout the design process instead of discovering weaknesses after the software has been built.

The top level categories in this view represent the individual tactics that are part of a secure-by-design approach to software development. The weaknesses that are members of each category contain information about how each is introduced relative to the software's architecture. Three different modes of introduction are used: Omission - caused by missing a security tactic when it is necessary. Commission - refers to incorrect choice of tactics which could result in [illegible]

```
memberOf CWE-1009_Audit
memberOf CWE-1012_Cross_Cutting
memberOf CWE-1017_Lock_Computer
memberOf CWE-1019_Validate_Inputs
memberOf CWE-1010_Authenticate_Actors
memberOf CWE-1011_Authorize_Actors
memberOf CWE-1016_Limit_Exposure
memberOf CWE-1018_Manage_User_Sessions
memberOf CWE-1020_Verify_Message_Integrity
memberOf CWE-1015_Limit_Access
memberOf CWE-1013_Encrypt_Data
memberOf CWE-1014_Identify_Actors

ID "1008"^^xsd:positiveInteger
```

Fig. 2 . CWE-1008 VIEW: Architectural Concepts.

Categories contains Bases, Classes, Compound, and Variations.
The ontology represented as a graph is given in Fig. 3.
The weakness properties are:

1. Description (Description)
2. The design phase during which this weakness can occur (architecture and design, implementation) (Modes Of Introduction)
3. Applicable platforms (based on programming languages): discusses weaknesses that may occur in applications developed in the Java programming language). (Applicable Platforms)
4. General effects (individual effects associated with weakness). Scope identifies the security scope of an application that is compromised, while

Impact describes the negative technical impact that occurs if an attacker manages to exploit the vulnerability. Probability provides information about how likely it is that a particular consequence is expected with respect to other consequences in the list. For example, there may be a high probability that a weakness will be used to achieve a certain impact, but a low probability that it will be used to achieve another impact. (Common Consequences)

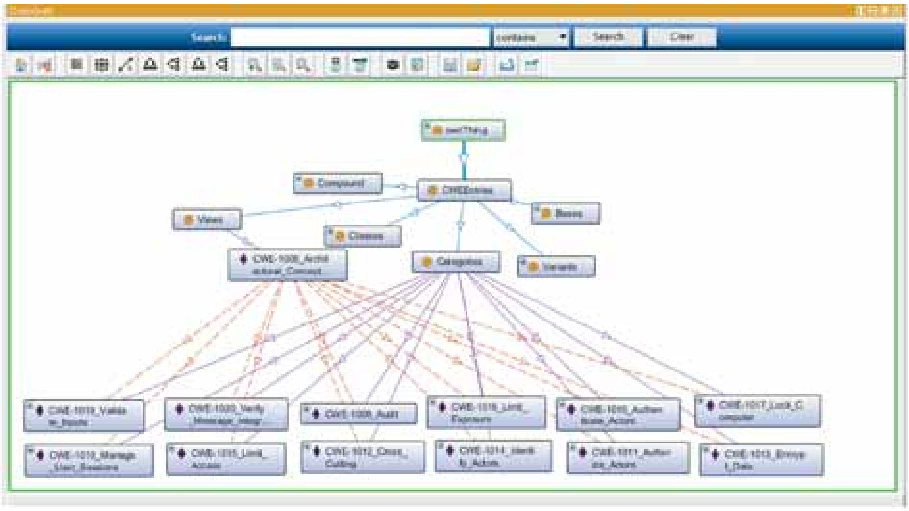
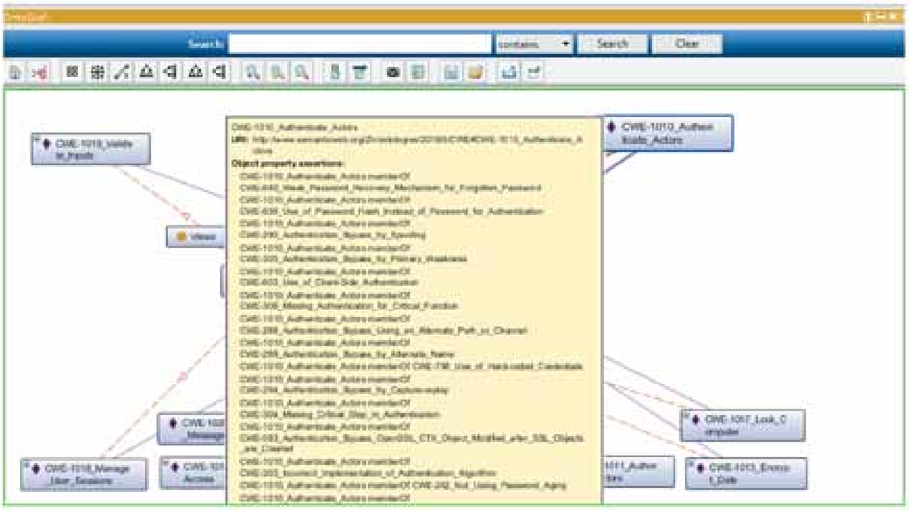


Fig. 3 . OntoGraph representation of architectural concepts.



CWE-1010_Authenticate_Actors
URI: http://www.semanticweb.org/[illegible]#CWE-1010_Authenticate_Actors
Object property assertions:
CWE-1010_Authenticate_Actors memberOf
CWE-640_Weak_Password_Recovery_Mechanism_for_Forgotten_Password
CWE-1010_Authenticate_Actors memberOf
CWE-836_Use_of_Password_Hash_Instead_of_Password_for_Authentication
CWE-1010_Authenticate_Actors memberOf
CWE-290_Authentication_Bypass_by_Spoofing
CWE-1010_Authenticate_Actors memberOf
CWE-305_Authentication_Bypass_by_Primary_Weakness
CWE-1010_Authenticate_Actors memberOf
CWE-603_Use_of_Client-Side_Authentication
CWE-1010_Authenticate_Actors memberOf
CWE-306_Missing_Authentication_for_Critical_Function
CWE-1010_Authenticate_Actors memberOf
CWE-288_Authentication_Bypass_Using_an_Alternate_Path_or_Channel
CWE-1010_Authenticate_Actors memberOf
CWE-289_Authentication_Bypass_by_Alternate_Name
CWE-1010_Authenticate_Actors memberOf CWE-798_Use_of_Hard-coded_Credentials
CWE-1010_Authenticate_Actors memberOf
CWE-294_Authentication_Bypass_by_Capture-replay
CWE-1010_Authenticate_Actors memberOf
CWE-304_Missing_Critical_Step_in_Authentication
CWE-1010_Authenticate_Actors memberOf
CWE-593_Authentication_Bypass_OpenSSL_CTX_Object_Modified_after_SSL_Objects_are_Created
CWE-1010_Authenticate_Actors memberOf
CWE-303_Incorrect_Implementation_of_Authentication_Algorithm
CWE-1010_Authenticate_Actors memberOf CWE-262_Not_Using_Password_Aging
CWE-1010_Authenticate_Actors memberOf

Fig. 4 . Object properties of CWE-1010.

1. The possibility of using
2. Illustrative example
3. Related vulnerabilities
4. Potential Mitigation
5. Detection method

Almost every CWE is associated with vulnerabilities and attacks.
A view of CWE-1010 object properties is given at Fig. 4.
Finally, CWE-287 is shown at Fig. 5 as graph in its environment.

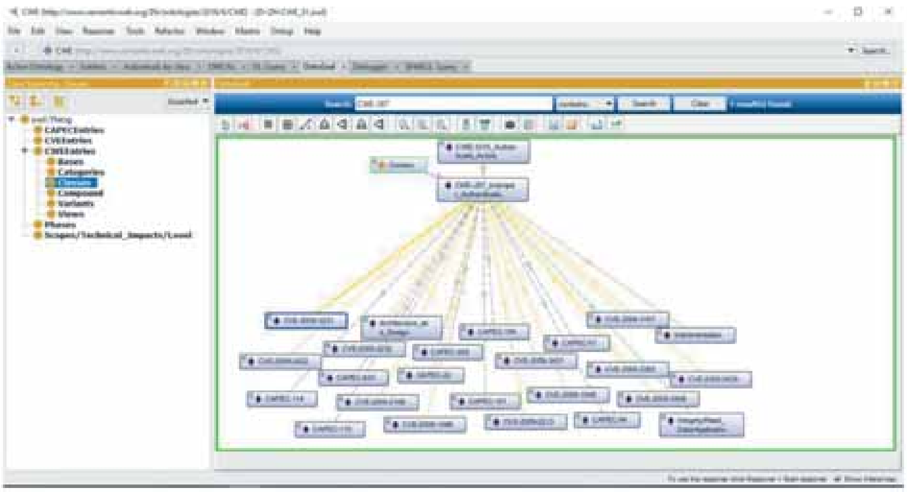


Fig. 5 . CWE-287 graph.

5 Conclusion

Proposed knowledge representation aims software developers to write secure code offering to them different views to the possible weaknesses in all development phases.

References

1. CWE, Common Weaknesses Enumeration, http://cwe.mitre.org
2. Protégé, https://protegewiki.stanford.edu/wiki/Main_Page