

EVAWEB v2: enhancing a web-based assessment system

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Abstract. Security is one of the main problems in web-based assessment systems, particularly guaranteeing non-repudiation of tests submissions. Authors have developed EVAWEB, a web-based assessment system that addresses this issue by using digital signatures. Moreover, the use of this technology in EVAWEB provides a real context to the students for learning digital signatures. In this paper, the enhancements that have been incorporated to EVAWEB in order to develop a second version of the system are presented.

Keywords web-based assessment, digital signatures, X.509/PKIX framework, non-repudiation, innovation in security teaching

1. Introduction

Security and privacy issues stand as some of the main problems of existing e-learning systems [1, 2]. Particularly, on-line assessment has been largely debated because of difficulties with properly authenticating the students and making their submissions non-repudiable. Non-repudiation is defined by the International Organization for Standardization (ISO) as the security property that provides protection against false denial of having been involved in a communication [3]. Non-repudiation of submitting and receiving a test is a desirable property in on-line assessment. This property is usually provided by logs in most known e-learning systems such as WebCT or Blackboard. Although digital signatures are a proper tool to provide non-repudiation security services [4, 5], these systems do not include this technology yet.

On the other hand, the understanding of digital signatures is crucial for students on information technologies and, to some extent, also for the general public, as electronic signatures have been given legal recognition recently in several countries. Traditionally, computer security curricula of undergraduate computer engineering programs include laboratory sessions that allow students to learn digital signature technology in practice using tools such as PGP and OpenSSL. As in many study areas, students learning process will be enhanced if learning-by-doing in context is used instead of making the students to realise a set of naïve academic exercises [6].

Authors have developed EVAWEB [7, 8], a web-based assessment system that focuses on non-repudiation requirements through the use of digital signatures. Furthermore, EVAWEB enhances the students' learning of digital signatures by providing them a real context to practice this technology. It has been developed in the context of an innovative education experience⁺ for the teaching of security on information technologies at higher education levels. The students learn the concepts involved in digital signature using them in their own assessment process.

The evaluation of EVAWEB by some students of Universidad Carlos III de Madrid has turned out as an above average success, but, at the same time, results highlighted the need of improvements in the system. In this paper, the enhancements that have been incorporated to EVAWEB in order to obtain a second version of the system are presented. The improvements are mainly focused in architecture, functionality, portability, interface, database and security aspects.

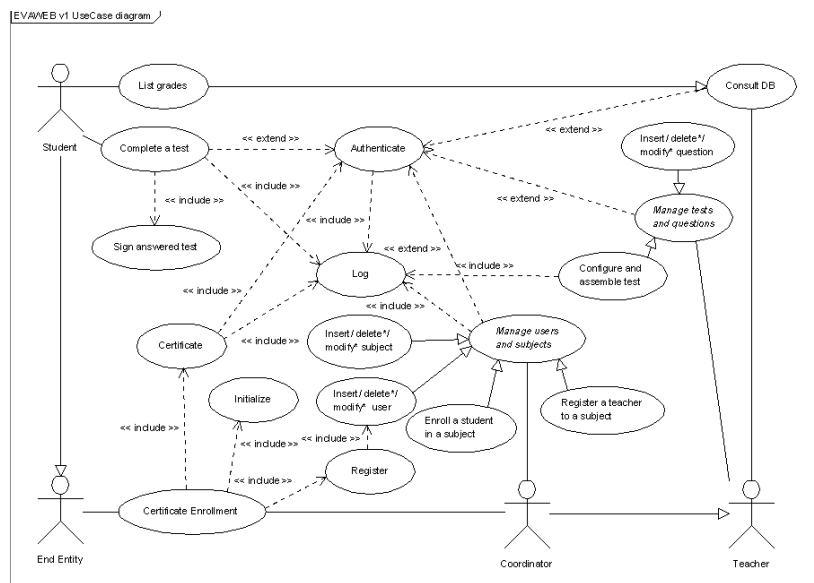
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The organization of the paper is as follows. In Section 2, the functionalities and architecture of EVAWEB v1 is described. Section 3 presents the enhancements that have been incorporated in EVAWEB. Finally, Section 3 exposes the conclusions and future work.

2. Description of EVAWEB v1

EVAWEB v1 allows teachers to administrate the creation and modification of tests for different subjects and groups of students as well as to assess the students automatically. The most innovative feature of EVAWEB is that neither students can repudiate the fact of having done a test (and the concrete answers) nor teachers can deny the reception of the test and the automatically generated mark. This is achieved using X.509/PKIX based digital signatures. When a student finishes an online test, he must submit it digitally signed to the EVAWEB server. The necessary Public Key Infrastructure (PKI) is provided by the system.



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Fig. 1 Use case diagram showing functionality of EVAWEB v1.

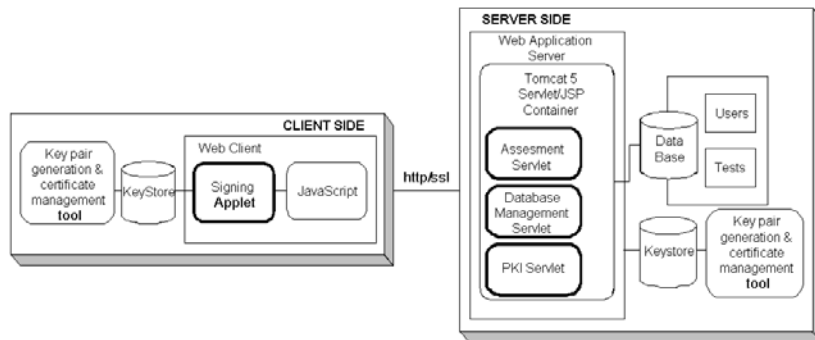


Fig. 2 Architecture of EVAWEB v1

EVAWEB v1 has a three-tier architecture composed by a web application running on a servlet container on the server side, and a web client supported by some processing capabilities on the client side. On the server side there are also a database with users and test information, and a repository with the CA's keys and public key certificates necessary to verify the signatures. On the client side, JavaScript is used to perform local form validations and to improve interactivity. The signature on the client side is performed via a signing applet which communicates with the user through java graphical interfaces and with the browser via JavaScript.

A use case diagram of the functionality of EVAWEB v1 is shown in Fig. 1, while Fig. 2 presents its architecture. For more details on the implementation of EVAWEB v1 see [7].

3. EVAWEB v2 as an enhancement of EVAWEB v1

As a result of the evaluation of the first version of EVAWEB, some deficiencies and a set of desirable improvements have been detected. A second version of the system has been launched including the changes needed to address these issues. These changes are described as follows.

1. **Architecture.** The most important change in EVAWEB v2 affects its software architecture, which has been redesigned using the Model-View-Control pattern to enhance its modularity and to ease its maintenance.
2. **Functionality.** EVAWEB v1 had a restricted set of functionalities related to the management of the database. Particularly, it was not possible to modify or delete data. Both functionalities have been added in EVAWEB v2. In addition, EVAWEB v2 allows teachers to issue students' digital certificates with a very simple process accessible from the web interface. On the contrary, EVAWEB v1 required the realization of annoying manual processes for each certificate.
3. **Interface.** Navigability through interface web pages has been refined, mainly, aspects related to form validation. Usability has also been enhanced by redesigning the aesthetics of web pages, at the same time that modularity and maintainability has been greatly improved with the use of web style sheets.
4. **Database.** In this case, some deficiencies in the design of EVAWEB v1's database have been corrected.
5. **Portability.** To enhance the portability of the system, in the first place, the database management system has been migrated from Microsoft Access to MySQL. In second place, configuration files have been created that allow the specification of installation variables, directory paths, passwords, etc.
6. **Logs.** Finally, in EVAWEB v2 a log framework has been integrated which allows the registration of all actions taken in the system. Furthermore, the results in the tests submitted by the students are doubly logged in one file and each of them in a separate file to ease its query.

4. Conclusions

One of the main security problems in on-line assessment is making students' submissions non-repudiable. Authors have developed EVAWEB, a web-based assessment system that focuses on non-repudiation requirements through the use of digital signatures. Furthermore, the developed system aims to enhance the students' learning of digital signatures by providing them a real context to practice this technology. In this way, the students learn the concepts involved in digital signature using them in their own assessment process.

A first version of EVAWEB has been evaluated successfully by some students of Universidad Carlos III de Madrid. However, the evaluation highlighted also the need of some improvements in the system. These enhancements have been incorporated to EVAWEB in order to obtain a second version and are mainly focused in architecture, functionality, interface, database, portability and security aspects.

Main future work includes the assessment of EVAWEB v2 by students in order to evaluate the effectiveness of the changes that have been introduced. In addition, new functionalities, such as generation of

statistics and printable documents (e.g., tests and reports), should be added. Finally, EVAWEB should be adapted to comply with web accessibility guidelines [9].

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