Title: Security Testing Training Description

Version: 1.0
Date : 21.5.2013
Pages : 28

Author: Teemu Tokola, University of Oulu, OUSPG

Reviewers: Jean-Luc RICHIER, Laboratoire d'Informatique de Grenoble (LIG), Fredrik Seehusen, SINTEF, Carlo Harpes, itrust consulting, Franz Wotawa, Technische Universitaet Graz

To: DIAMONDS Consortium

The DIAMONDS Consortium consists of:
Codenomicon, Conformiq, Dornier Consulting, Ericsson, Fraunhofer FOKUS, FSCOM, Gemalto, Get IT, Giesecke & Devrient, Grenoble INP, itrust consulting, Metso, Montimage, Accurate Equity, SINTEF, Smartesting, Secure Business Applications, Testing Technologies, Thales, TU Graz, University Oulu, VTT

Status:

[ ] Draft
[ ] To be reviewed
[ ] Proposal
[X] Final / Released

Confidentiality:

[X] Public — Intended for public use
[ ] Restricted — Intended for DIAMONDS consortium only
[ ] Confidential — Intended for individual partner only

Deliverable ID: D5.WP5.T3

Title:

Security Testing Training Description

Summary / Contents:

This document reports the D5.WP5.T3 deliverable, the security testing training description. It outlines the integrated training environment technical implementation, the trainings currently available, the trials done in university courses and performance tests of the environment.

© Copyright DIAMONDS Consortium

TABLE OF CONTENTS

1. Introduction 5
1.1 Background on dissemination in general 5
1.2 Background on security dissemination 6
1.2.1 Targeting the executives – presenting the cost of security choices 7
1.2.2 Targeting technical executives – security as quality 8
1.2.3 Targeting technical personnel 8
1.2.4 Targeting researchers 9
1.2.5 Targeting the general audience 9
1.3 The Essential dissemination challenge 9
1.4 Background on security testing training environment 10

2. Integrated training environment 11
2.1 Features – user interface 12
2.2 Features – authoring or administrative interface 15
2.3 Built on Django development platform 17
2.4 Relation to chapter 1 19
2.4.1 Executives 19
2.4.2 Technical executives 19
2.4.3 Technical personnel 19
2.4.4 Researchers 19
2.4.5 General audience 20

3. Adopted trainings 21
3.1 How to create a new training in DIAMONDS 21
3.2 Introduction to testing with fuzzing 22
3.2.1 Jyväskylä training seminar 23

4. Environment trials 24
4.1 First pilot 24
4.2 Second pilot 24

5. SYSTEM PERFORMANCE 25

6. Conclusion 27

© Copyright DIAMONDS Consortium

FIGURES

Figure 1. Impact scope of different types of results 6
Figure 2. The positive cycle of dissemination 10
Figure 3. Training system course selection screen 12
Figure 4. Course main page featuring multimedia, a question and the navigation 13
Figure 5. Content page featuring text input questions being answered 14
Figure 6. Administrative interface main menu screen 16
Figure 7. Administrator interface provides advice on required actions 17
Figure 8. The Django development platform 18
Figure 9. Content page from the "How to create a new training in DIAMONDS" -training 22
Figure 10. Content page from the "Introduction to testing with fuzzing "-training 23
Figure 11. Apachebench software available at http://httpd.apache.org/docs/2.2/programs/ab.html 25

TABLES

Table 1. Evaluating impact of dissemination activities 5
Table 2. System performance under load 25
Table 3. System performance under file submission tasks 26

HISTORY

Vers.	Date	Author	Description
0.1	14.10.12	Teemu Tokola	Draft
0.2	14.11.12	Teemu Tokola	To be reviewed
0.3	3.12.12	Teemu Tokola	Proposal
0.4.	2.5.13	Teemu Tokola	To be reviewed
0.5	21.5.13	Teemu Tokola	Proposal
1.0	21.5.13	Christian Wieser	Final version

APPLICABLE DOCUMENT LIST

Ref.	Title, author, source, date, status	DIAMONDS ID
1		

© Copyright DIAMONDS Consortium

EXECUTIVE SUMMARY

Dissemination of results is of key importance in any research and development activity: the outcomes need to be communicated clearly and concisely to the target audience in order to produce the desired impact on the concerned activities.

This document describes the security testing training system developed in the DIAMONDS project that facilitates the process of dissemination by providing an interactive platform for dissemination of project results via engaging exercises and multimedia content.

The system has been piloted in university courses to ensure the system is mature enough for general use, and has achieved sufficient results in performance tests.

To showcase its capabilities, two training materials have already been introduced into the system: one on how to create a new training and one on the work that OUSPG has done in the project on fuzzing testing.

© Copyright DIAMONDS Consortium

1. INTRODUCTION

The integrated training environment developed in the DIAMONDS project supports the publications and trainings activities of T5.3. The training environment is aimed at practitioners in the field of security testing, but the technology allows it to be used for any setting. For example, for providing a common training environment for a group of results at events such as the Fourth International Workshop on Security Testing, in which the DIAMONDS project presented several results.

1.1 BACKGROUND ON DISSEMINATION IN GENERAL

The essential problem in large projects and in research in general, is that the results often work to some extent, or could provide added value, but they are not communicated clearly enough to the outside community for them to influence existing practices. Efficient dissemination of results, then, becomes of prime importance for any consortium that intends to have an impact on the field they are investing in.

Dissemination and its potential for impact are determined on the other hand by the merits of the research itself, but on the other hand on the efficiency of the dissemination activities. Given that the results have the potential of being course-changing both in research and industry, Table 1 outlines how the reach of the dissemination changes the outcome of the activities.

	No reach	**Limited reach**	**Large reach**	**Extensive reach**
Impact on research	No new research is started based on the results, and the research lines studied in the project do not continue.	The research is continued in the affiliated research groups, but attains only little attention from outside, and at best, the research is referenced in some papers.	The research is widely cited, and new studies and research are started which can be at least partially attributed to the research done in the consortium.	The research begins a completely new direction for research in the concerned field, and is later on considered to be a turning point in that particular field of research.
Impact on industry	No commercial players adopt any of the practices and results developed. There is no industrial gain from the project.	Limited number of companies, usually the ones affiliated with the project in the first place, adopt some of the practices developed.	A large number of companies, also outside the initial consortium partners, change their existing practices and / or adopt new ones based on the dissemination performed.	The results attain widespread interest and shape the face of the industry with regards to the practices and methods developed in the consortium.

Table 1. Evaluating impact of dissemination activities

The results itself, then, can obviously have a profound effect on which of these can be reached at all. Roughly, the results can be divided into three groups:

- Best practices and methods
  - These results have limited research interest but large potential effect on industry
- Foundational research

© Copyright DIAMONDS Consortium

- These results have potentially large research interest, but their industrial application and actual implications might be years ahead.

- Breakthroughs
  - Scientific breakthroughs which have immediate and impressive applications in industry and also wide scientific implications have the potential of having a large impact on both axis

The type of the results has an effect on the approach by which dissemination should be done and how it should be evaluated. As shown in Diagram 1, each of these types can have a largely varying impact scope, and the success of any dissemination activity should be measured against whether how high up and far right in the diagram the measured impact has been.

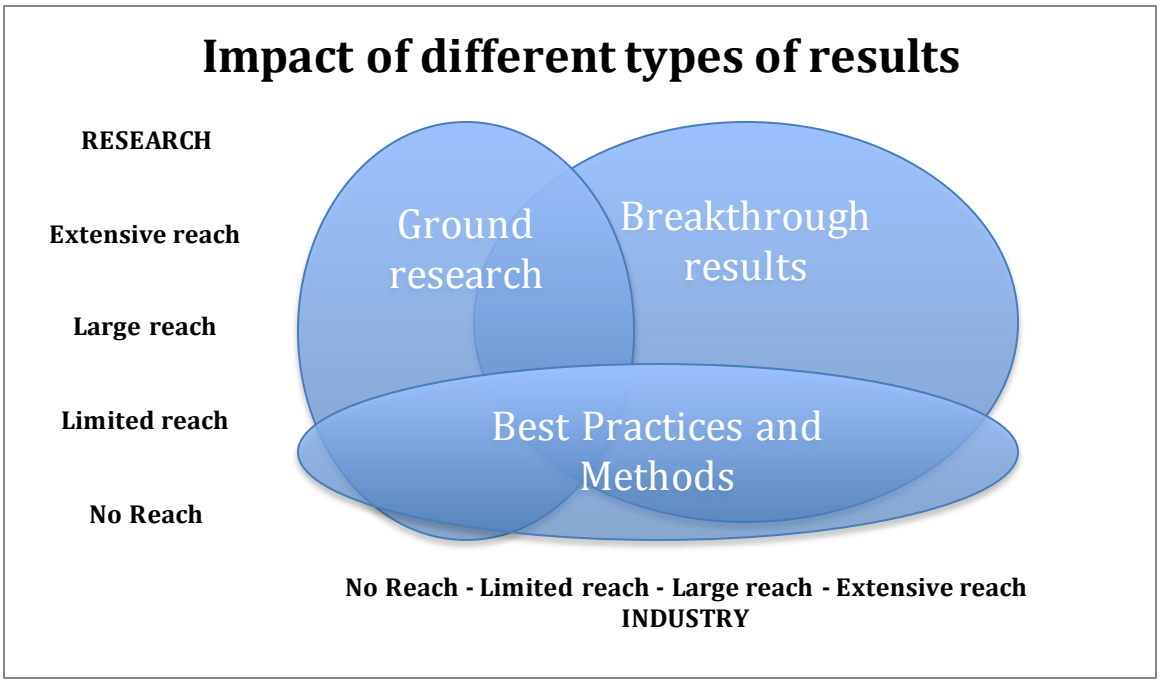

Figure 1. Impact scope of different types of results

1.2 BACKGROUND ON SECURITY DISSEMINATION

The dissemination of security testing research is a challenging topic. By definition security features are necessary and important, but on the practical level, application of security testing or testing in general is a source of additional cost. The dissemination activities have a number of audiences, which need to be targeted slightly differently:

- Executives
  - The people in charge of spending
  - Savings, added revenue and decreased overall cost are the main hooks
- Technical executives
  - The people in charge of making suggestions and / or decisions on which technology to adopt
  - Process and product quality increases without significant additional work or cost are the main arguments for this target group
- Technical personnel
  - The people implementing technologies

© Copyright DIAMONDS Consortium

  - The coders, designers, testers
  - Quality benefits, ease of adoption, less redoing are the main arguments for this target group.
- Researchers
  - The people who develop the results further or derive use in other research from the results
  - The significance of the scientific side of the results is the main argument towards researchers; in addition to the ease of applying the methods shown in one's own research.
- General audience
  - The laypeople who could be affected by security policies and technologies adopted.
  - For the average layperson the main argumentation centres on why they should be concerned with the adoption or lack of adoption of security methods and practices shown – that the threats associated are real and that they can protect themselves or make security-conscious buying decisions without becoming too involved with the exact details.

1.2.1 Targeting the executives – presenting the cost of security choices

For the executive target group, different security choices and practices need to be presented in terms of cost that these different choices cause. The target group should not see only the cost of development and the drain on resources that security-conscious approaches cause, but also the cost implications of failed security-cost of sales by bad public relations, other economic losses, reputational damage to people in charge etc. Security dissemination should then answer in advance to the executive level audience, what implications individual practices and security products have on these costs.

With regards to cost, there are the costs incurred by the adoption of security practices and products, the positive income caused by adoption of certain practices that provide certificates, and finally the costs caused by loss of sales, damages, repairs etc. that are caused by PR damages caused by publicised security failures.

The cost of security feature adoption typically depends on the phase at which testing is adopted.

- Design
  - Taking all security issues into account as a system is being designed can cause significant delays and incur extra cost. Some things may not be possible to be done in a secure fashion.
  - At this level, however, the cost of added security is at its lowest.
- Development
  - Thorough testing during development is another source of delay and cost.
  - It may also uncover flaws in design which cause extensive redesigning.
  - Testing at this point, however, does not incur as significant costs as later on.
- Testing
  - A thorough testing in the testing phase of a products could also cause delays from possibly set deadlines on publication.
  - At worst, testing could lead to significant redesigns.
  - Costs incurred are significant, but much less, than at later stage.
- Production
  - Serious security defects (and less serious ones too) could lead to massive costs especially in the case of hardware, as products need to be pulled from the selves and already sold units need to be repaired at the cost of the manufacturer.
  - The costs of added security are at its highest at this level.

While avoiding these problems would seem like the top priority given that the amount of cost for repairs increases as time goes on, often testing and security is neglected at the initial steps, and the approach all too easily becomes about if we could simply pretend there are no problems and hope that no-one finds out there

© Copyright DIAMONDS Consortium

are. The target of dissemination activities then becomes convincing executives, that security-conscious approach may cause costs at the outset, but save costs when the entire production cycle is taken into account.

1.2.2 Targeting technical executives – security as quality

Technical executives and other people in charge of technical decisions and acquisitions need to be made aware of the implications and potential benefits of security approaches, models, methods and software. For them, the key issues are improved quality and improved processes while not forgetting that they too are concerned with the amount of work.

Given the amount of material offered to any technical executive, to separate itself from others, the dissemination of security research must:

- Clearly identify the added quality and security it provides
  - Why the investment of work and funds is worth it
- Clearly identify the part of the production process that the method improves, if the method is related to the production method
  - This allows the technical executive to assess how the method or software relates to other tools at his disposal
- State, whether the tool or methodology is intended to be used in addition to existing tools and methods, or to be a replacement for others
  - In case of additional tools, clear justification needs to exist for adding yet another methodology or tool to the existing array of different methods and tools
  - In case of replacement tools, the smaller effort or improved results and the reduced licence fees or similar costs should be plotted against a realistic expectation of incurred training costs and fees of adopting the new method or tool
- The type of security that the approach provides should be stated in clear, unambiguous terms using common terminology

So, in essence, for the technical executive, it is necessary to quantify the effect of adoption on

- Confidentiality
  - Information does not leak outside
- Integrity
  - No unauthorised modification of information
- Availability
  - Information is available when needed
- Authenticity
  - Communication participants are who they claim to be
- Non-repudiation
  - Transactions can be verified to have happened

And clearly communicate which parts of the production process are affected and how to give the technical executive sufficient information to weigh the gains compared to the costs incurred.

1.2.3 Targeting technical personnel

Technical personnel are an important target group for security-related dissemination, as they can often have a large effect on what practices and tools companies adopt, and being the implementers of their systems, an up-to-date knowledge on latest methodologies may improve security even without executive decisions.

The key communication points for technical personnel are:

© Copyright DIAMONDS Consortium

- Increase of quality vs. effort spent
- Less severe incidents and as a result, less sudden high-priority update sprints
- Impact on own expertise – possibility to keep skills up-to-date

1.2.4 Targeting researchers

Targeting researchers often happens almost exclusively through scientific publications and conferences, and obviously any dissemination targeted at researchers should use these routes to promote the produced results.

1.2.5 Targeting the general audience

"Through 20 years of effort, we've successfully trained everyone to use passwords that are hard for humans to remember, but easy for computers to guess" (http://xkcd.com/936/)

Depending on the type of results, targeting the general audience may or may not be of importance. If, however, that particular dimension exists, then it presents significant challenges on how research results can be popularised in a way that leads to efficient dissemination of the practice or tool in question.

The popular quote shown above illustrates this issue: while new findings in security research and development of different attack tools have led to the situation, that old knowledge on password creation is antiquated and even hazardous for information security, this has not (as of yet, at least) led to a change at the level of society. Instead, people still rely on short passwords that are easy to crack using brute-force methods.

In similar vein, it is clear that while communication to the public at large needs to be simple and concise, great care has to be taken to ensure that simplifications made do not cause the message to be distorted such, that the outcome is jeopardised.

1.3 THE ESSENTIAL DISSEMINATION CHALLENGE

While acknowledging the scope and impact issues and the differing needs of the different target groups if security related dissemination, the essential challenge in dissemination deserves its own subchapter. The essential challenges, in short, are:

- Reaching the target audience
- Engaging or priming the target audience to receive the message
- Keeping them interested long enough to absorb the essentials of the message
- Convincing them of the importance of the issue

All of these parts present important obstacles that need to be overcome, for the dissemination to have successful outcome. As shown in Figure 2, these parts of the challenge form a reinforcing cycle, in which a successful dissemination process leads to the audience taking the message further and bringing more audience to hear about the results.

The system described in this document addresses the issues of Engaging, Keeping and Convincing, but the problem of getting the target audience to reach the website where the training system resides remains outside the scope of the system itself.

© Copyright DIAMONDS Consortium

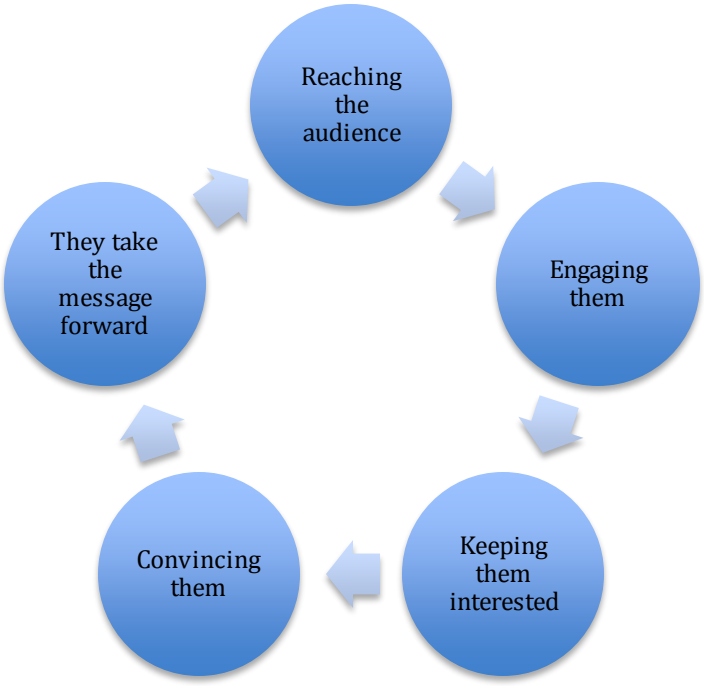

Figure 2. The positive cycle of dissemination

1.4 BACKGROUND ON SECURITY TESTING TRAINING ENVIRONMENT

The problems and challenges outlined in the previous subchapters form the intellectual basis for the work done for the security testing training system outlined in this paper.

Whatever the result type (see subchapter 1.1) is, what we want, is to reach the maximum possible impact given these results. While this work does not consider too much the question of how we reach all of the target audience (see subchapter 1.3), the work described here attempts to perform as well as possible in the other parts of the challenge.

The integrated training environment is intended mostly for the technical personnel and researchers, although also technical executives and some parts of the general public might be interested (see subchapter 1.2). This is because the implementation of the system strongly favours technical problems. For presentations that target the executives and majority of the general public, some other, more visual medium would be more appropriate. In such a system, the question is less about exercises and training and more about reinforcing a simplified, concise message: “this is how security saves costs” for the executives and “this is how you remain safe” for the general public. However, subchapter 2.4 presents how the system could regardless be used for targeting the other target groups.

The essential target for the integrated training environment is to provide a medium, in which those, who have produced results, can easily produce exercises and trainings to disseminate those results and stress their significance to their audience. A central point of dissemination for a large consortium also means, that while the audience finds their way to one of the results, the rest of the results produced in the consortium are also readily available in the same location.

© Copyright DIAMONDS Consortium

2. INTEGRATED TRAINING ENVIRONMENT

The integrated training environment developed for the DIAMONDS project is accessible via Internet connection using an ordinary Internet browser.

The system is available at the Internet address:

http://diamonds.virtues.fi

The system is divided into three parts:

- Publicly available training pages
- Authoring pages available only to those with the required privileges

In the publicly available training pages members of the audience can complete trainings, attempt exercises and familiarise themselves with the results have been published via the page. The users can do everything without logging in, but if they want to keep their old answers, they need to log in before answering questions and exercises.

The authoring pages are available to those registered users that have been given the privileges to access the administrator pages, where the authoring of content is done. In that part of the system, new trainings can be created, content added and various measures of the trainings can be monitored.

© Copyright DIAMONDS Consortium

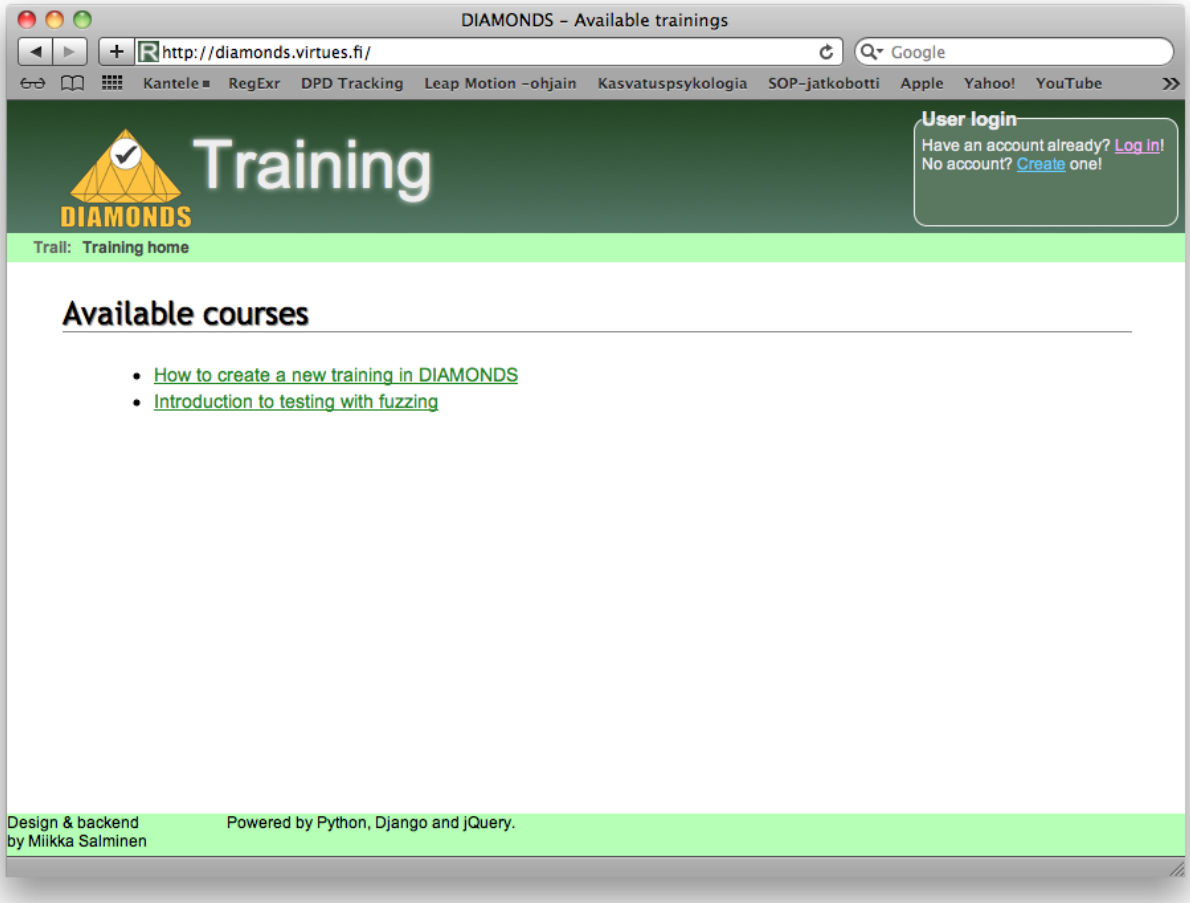

Figure 3. Training system course selection screen

2.1 FEATURES – USER INTERFACE

The user interface is the interface through which the audience interacts with the system, by completing exercises, watching videos and reading contents. The main screens are:

- Course selection screen
- Course main page and navigation screen
- Content/exercise pages

The course selection screen, shown in Figure 3, represents the place where the user decides which contents he wants to study, namely allows the user to select between the different courses that have been inserted into the system.

The course main page shows the introductory content for the course in question and the navigation selections for the course. The navigation shown on top of the screen in Figure 4 allows the user to select which part of the course he wants to study at this time.

© Copyright DIAMONDS Consortium

The exercises, as shown in for example Figure 5, provide immediate feedback on the submitted answers, allowing the user to quickly proceed without cumbersome waiting time, although, as outlined later on, file submission tasks in which the user submits a file instead of a direct answer, take slightly longer to process.

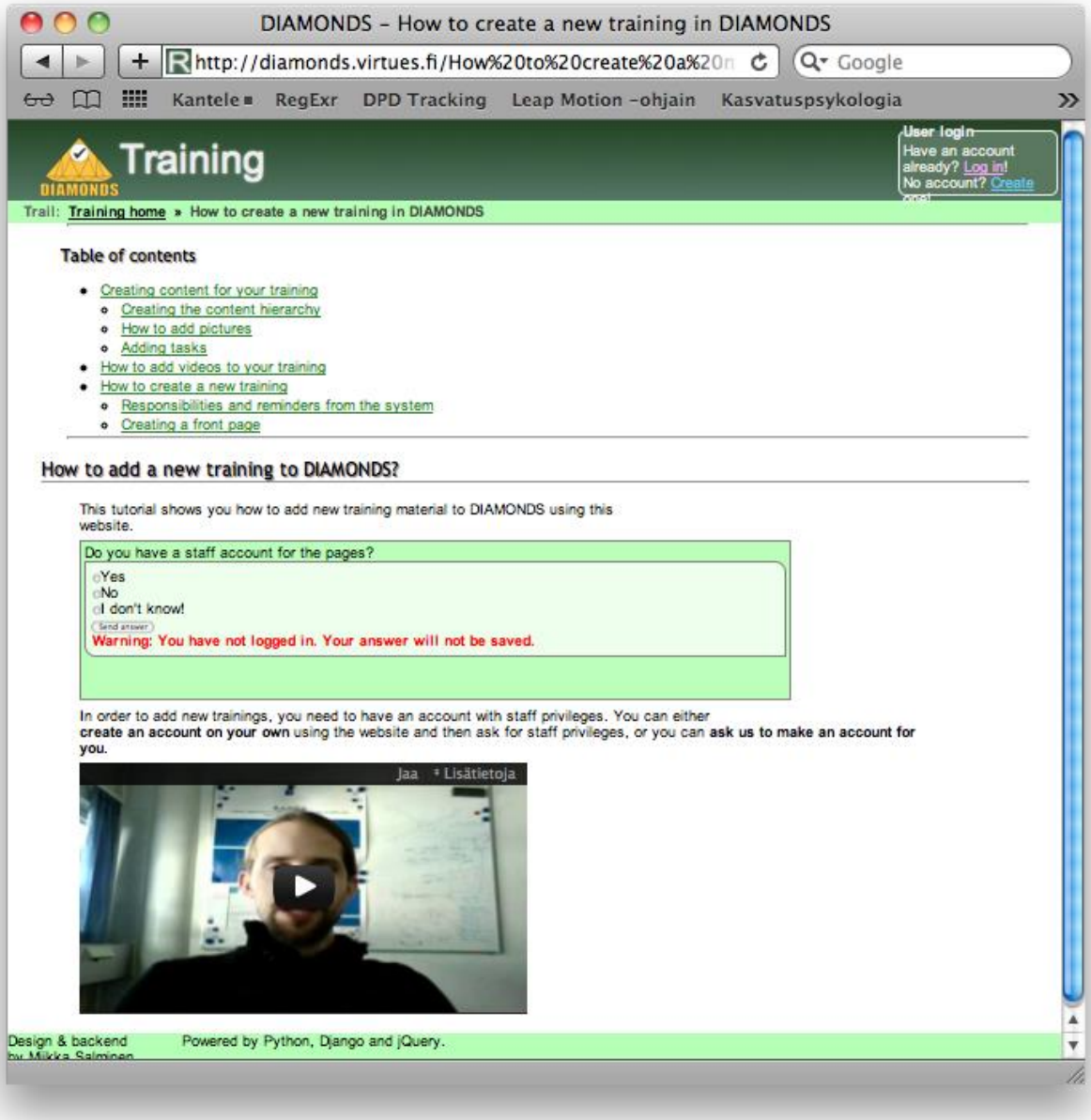

Figure 4. Course main page featuring multimedia, a question and the navigation

The users encounter two main types of content:

- Text content
- Multimedia content (video and images)
- Interactive exercises

The interactive exercises provide the normal functionalities one comes to expect from an exercise system:

© Copyright DIAMONDS Consortium

- Basic exercise types
  - Multiple choice
  - Radio button exercises
  - Text input
- Immediate feedback on the answers with hints for incorrect answers
- File submission exercises
  - The system can compile and execute program files from the user
  - This is done in a sandbox environment, so the user programs do not run on the same environment as the rest of the system.

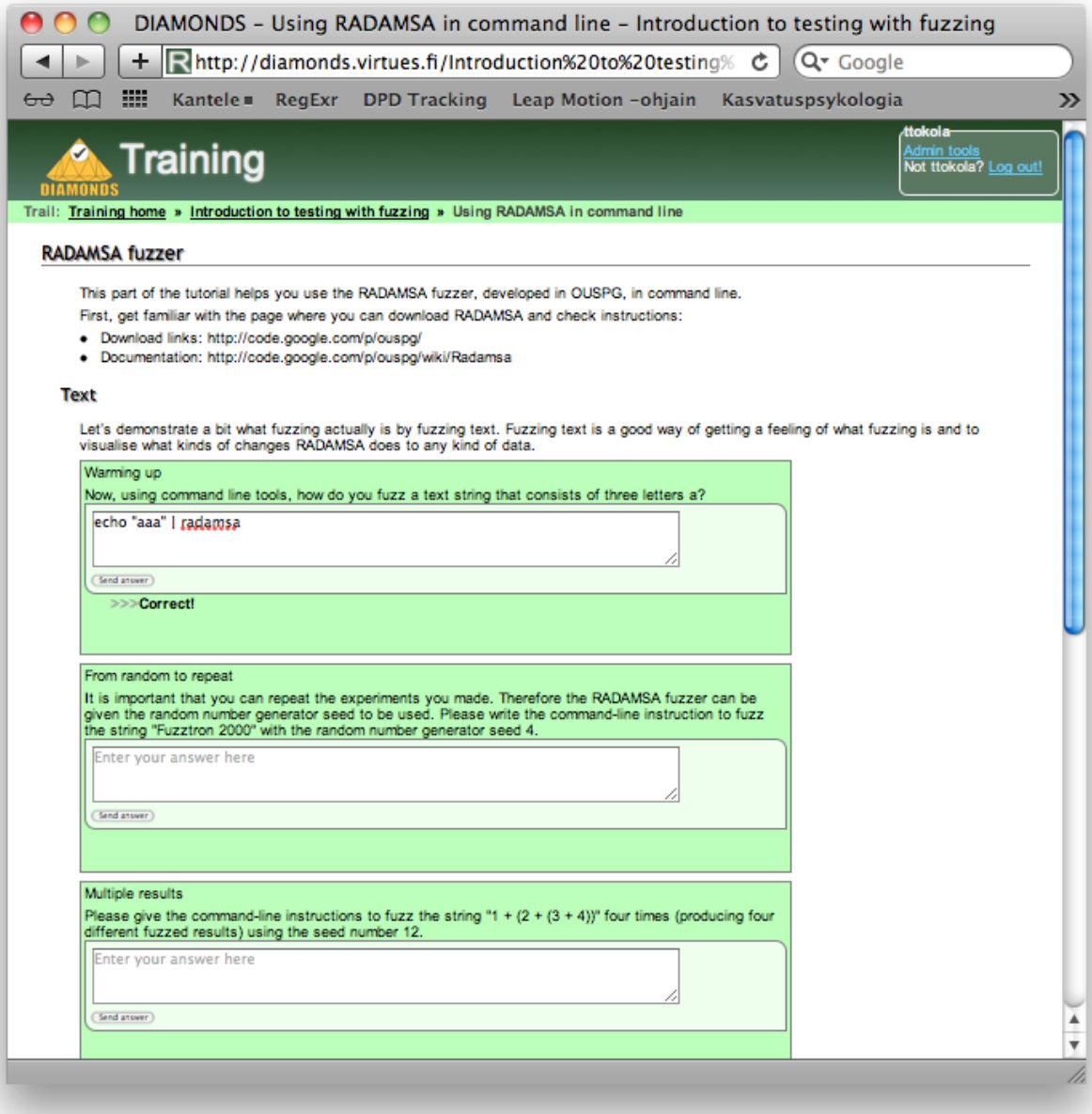

Figure 5. Content page featuring text input questions being answered

© Copyright DIAMONDS Consortium

2.2 FEATURES – AUTHORING OR ADMINISTRATIVE INTERFACE

The authoring interface, which is accessible to those users who have been given administrator privileges, allows the users to:

- Create new training courses
- Create content and associate it with training courses
- Create a number of different types of questions and embed them into content pages.
- Link external multimedia (video) to the content pages

© Copyright DIAMONDS Consortium

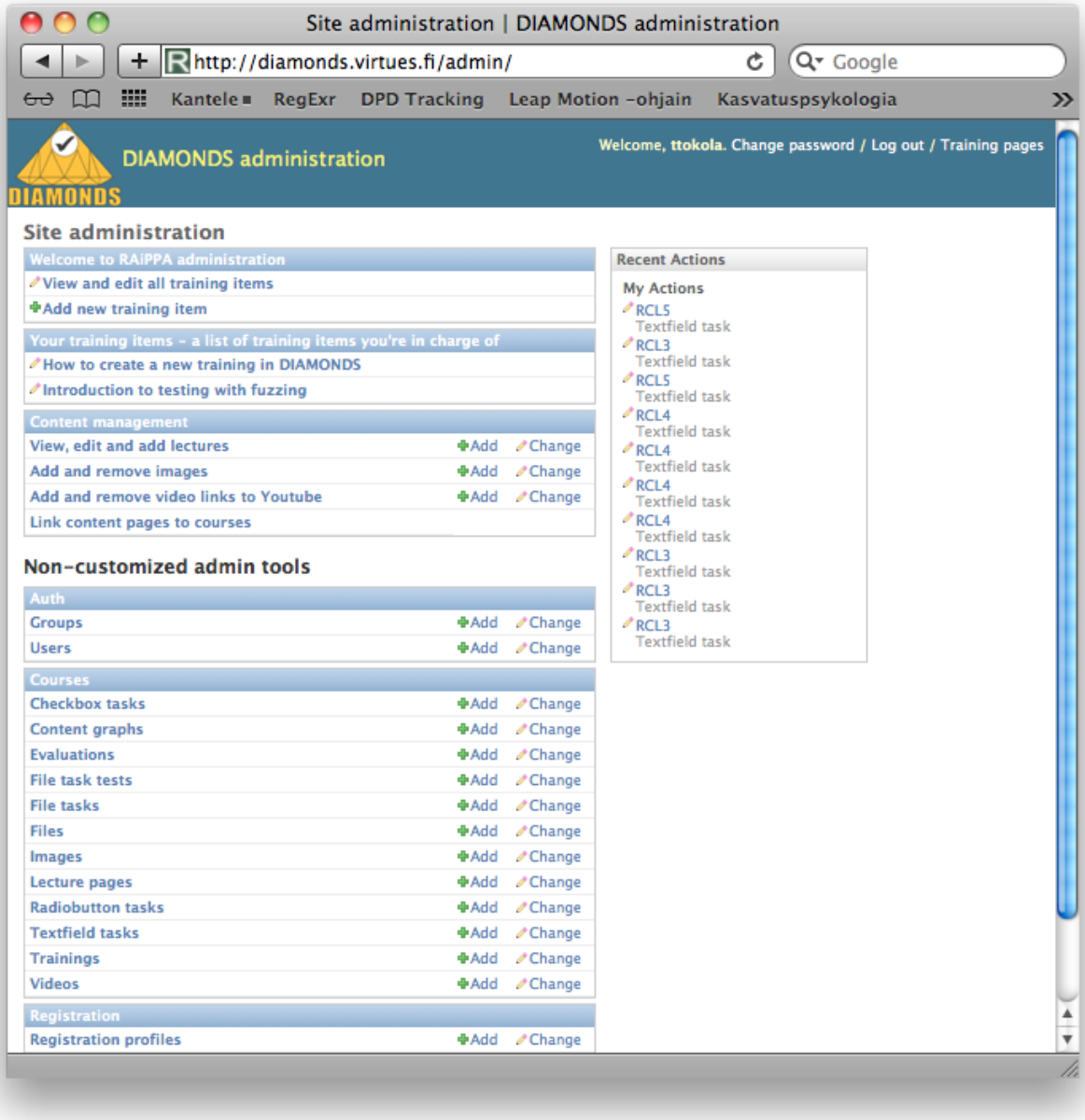

Figure 6. Administrative interface main menu screen

In addition to the editors provided, the system provides a number of different types of advice for helping he contributors improve and develop their training contents, as shown in the figure below. This is to ensure, that trainings do not remain incomplete but are completed on time, and also to help the contributors to react to any omissions in the designed trainings.

© Copyright DIAMONDS Consortium

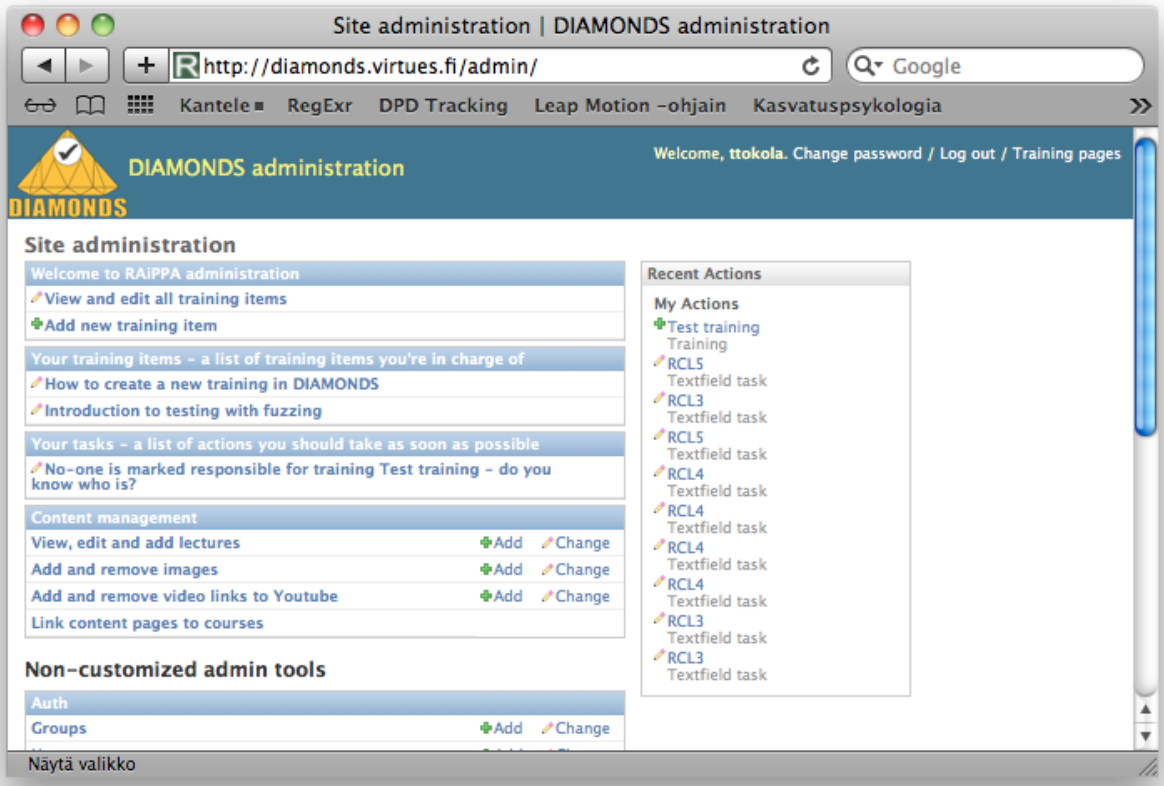

Figure 7. Administrator interface provides advice on required actions

2.3 BUILT ON DJANGO DEVELOPMENT PLATFORM

The system is implemented on top of the Django development platform (https://www.djangoproject.com/). The Django development platform provides the basic functionality and tools required most applications, and allowed the DIAMONDS security training environment project both to concentrate on producing the unique functionalities required in this project and also to benefit from the large developer community behind the Django project for selecting off-the-shelf solutions to problems others have already faced and also to benefit from the robust basic implementation that Django and its large developer base have provided.

© Copyright DIAMONDS Consortium

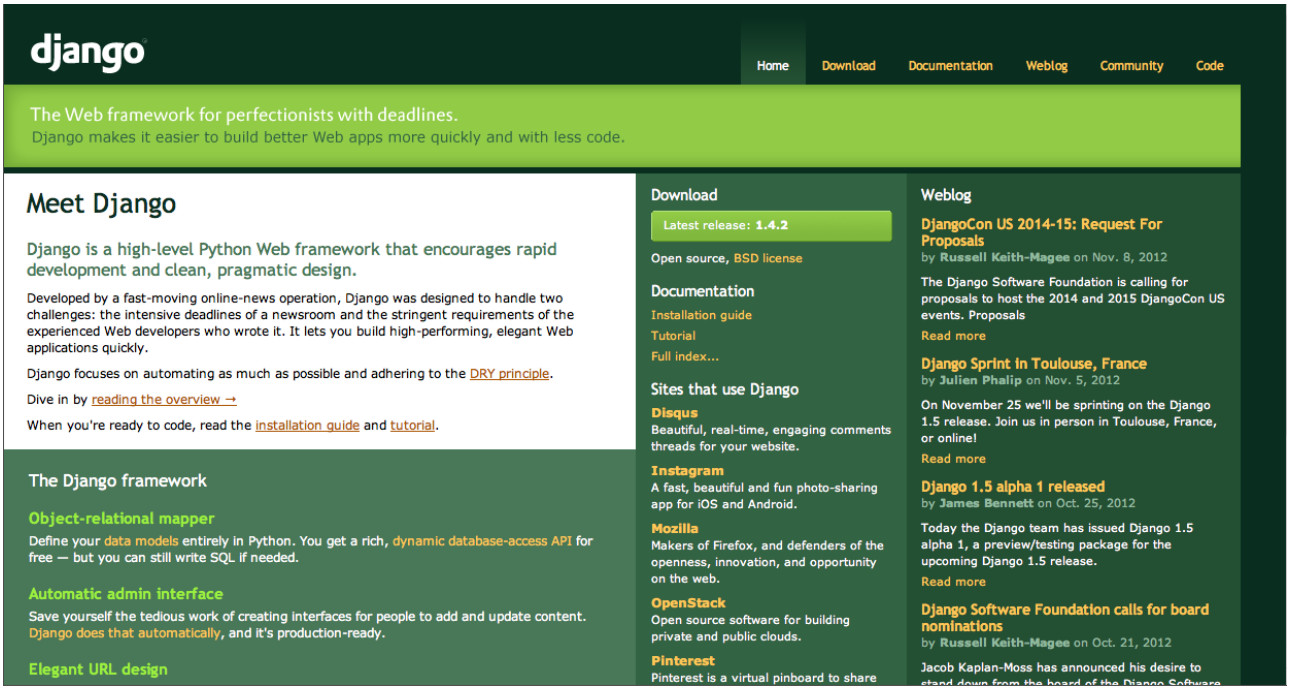

Figure 8. The Django development platform

© Copyright DIAMONDS Consortium

2.4 RELATION TO CHAPTER 1

.
In chapter 1.2 the target audiences for security dissemination were defined as:

- Executives
- Technical executives
- Technical personnel
- Researchers
- General audience

Although the system presented in this chapter is not an exact match to the dissemination needs of all these target groups and is best suited for technical personnel and researchers, this subchapter defines the possibilities offered with regards to each of them.

2.4.1 Executives

When creating materials for executive level decision makers, it is essential that the material created answers the specific needs of this target group: the material needs to clearly outline the costs, savings and added revenue based on adopting the techniques, tools or methods presented.

The exercises, if any, need to further illustrate this point by making the savings, revenues and costs concrete by the way of examples, in which the executives can themselves reach the conclusion, that adoption would be a wise decision for the organisation described in the exercise.

2.4.2 Technical executives

For the technical executives the process of adoption and production use, and the changes that they cause both quality-wise and process-wise need to be clearly shown in the exercises. It could be useful to have a separate training for different target groups, in which the different needs, justifications and levels of technical detail can be properly emphasized.

The exercises should allow the technical executives to get a clear picture of what effect the adoption of the methods, tools or processes would have on their process. The technical executive needs to get excited about the possibilities offered, so the exercises created into the system ought to make the benefits very clear and tangible, possibly showing solutions to problems in their process that the executive is already worried or conscious about, so that he feels that the is just like it's made for their needs.

2.4.3 Technical personnel

For the technical personnel, showing the how and the why is the starting point to the main task of getting them excited about the possibilities and offering suitable advice to their executives for adopting the tools, methods or practices. This target group, as previously mentioned, is the one that the tool shown in this chapter is most suited for.

2.4.4 Researchers

For the researchers, another group that the tool is well suited for, it is equally important that the audience gets excited about the possibilities that the tool offers for research.

© Copyright DIAMONDS Consortium

2.4.5 General audience

The tool is perhaps the most ill-suited for general audience, which is a far too diverse a group to make it feasible to design a single material and exercises to target them all. Also, the possibilities for getting the members of the general public to become involved and concerned enough to access the pages and make exercises are rather limited. However, should it be possible with regards to the topic of the training to target some specific group from the general public and target suitable advertisement to them so that a reasonable number could be directed to the training, it should be possible to design exercises and material that cater to this specific part of the general public.

© Copyright DIAMONDS Consortium

3. ADOPTED TRAININGS

The training environment currently showcases the following trainings:

- How to create a new training in DIAMONDS
- Introduction to testing with fuzzing

These trainings have been implemented on one hand to demonstrate the capabilities of the system, and on the other, to demonstrate the work done for DIAMONDS at OUSPG with regards to fuzzing.

3.1 HOW TO CREATE A NEW TRAINING IN DIAMONDS

The first training available in the system, the “how to create a new training in DIAMONDS”-training, provides the interested contributor a step-by-step guide of how to use the administrative interface for creating contents and gathering those contents into a training with interactive exercises. This is, then, in effect the first stop for anyone who wants to contribute to the available trainings by creating his or her own.

The training contains a number of content pages, each of which handles a specific aspect of creating a training. For those, who prefer watching to reading, helpful videos have been produced to serve as a support material for the text, although the videos can also be used stand-alone.

© Copyright DIAMONDS Consortium

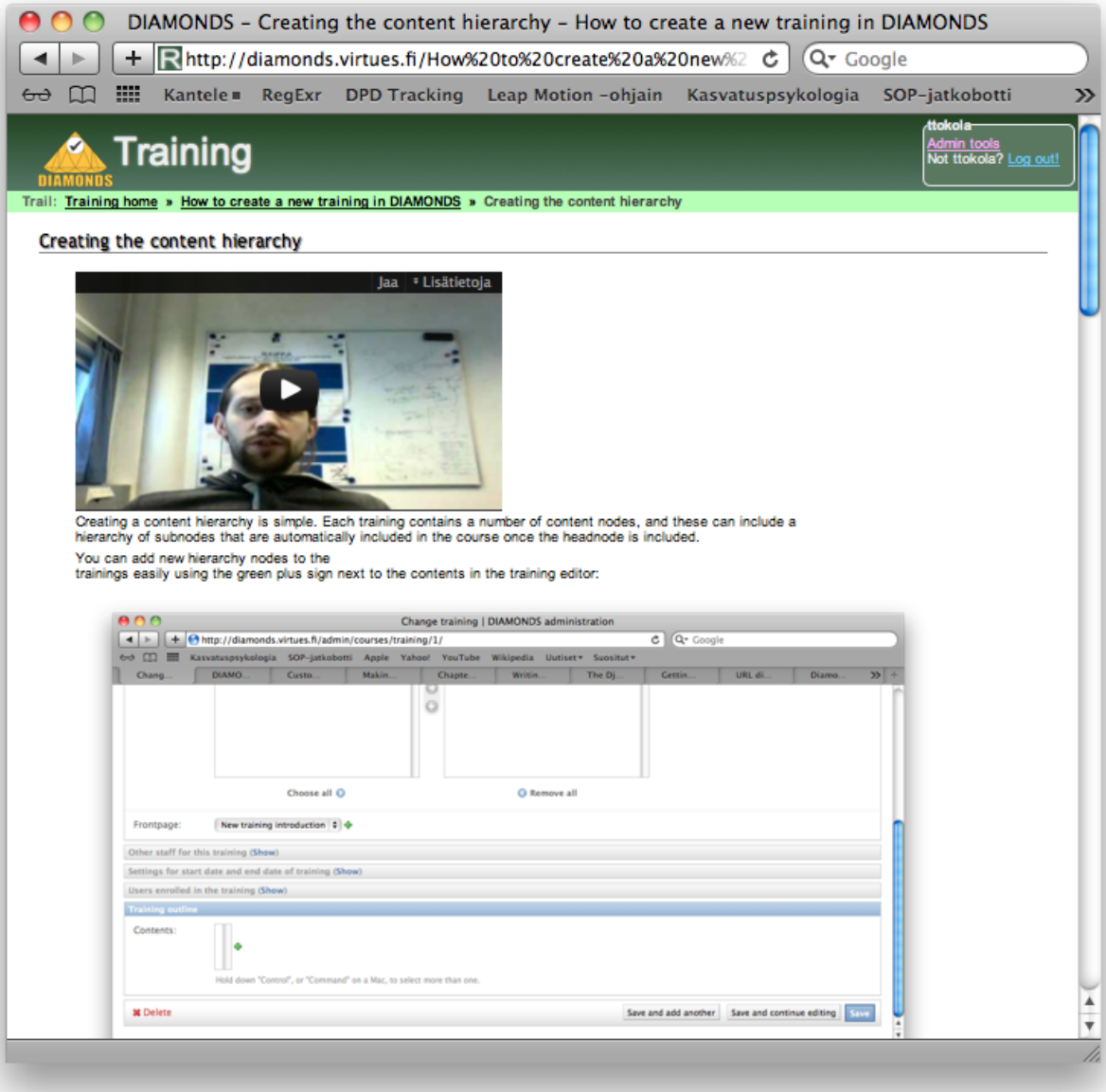

Figure 9. Content page from the "How to create a new training in DIAMONDS" -training

3.2 INTRODUCTION TO TESTING WITH FUZZING

The other available training in the system at the time of this writing is the “Introduction to testing with fuzzing”-training, which showcases the work done for the DIAMONDS project in the OUSPG on the field of fuzz testing. The training is a complete material which shows the user how to use the actual fuzzier for producing output, and also on how to take this fuzzer and create a fuzzing testing infrastructure which can then automatically test the programs it was designed for.

This training is mainly aimed at technical personnel. (See chapter 1). The justification is to create a training that shows technical personnel how a fuzzer is used and how it can be incorporated into a part of an automated test system.

© Copyright DIAMONDS Consortium

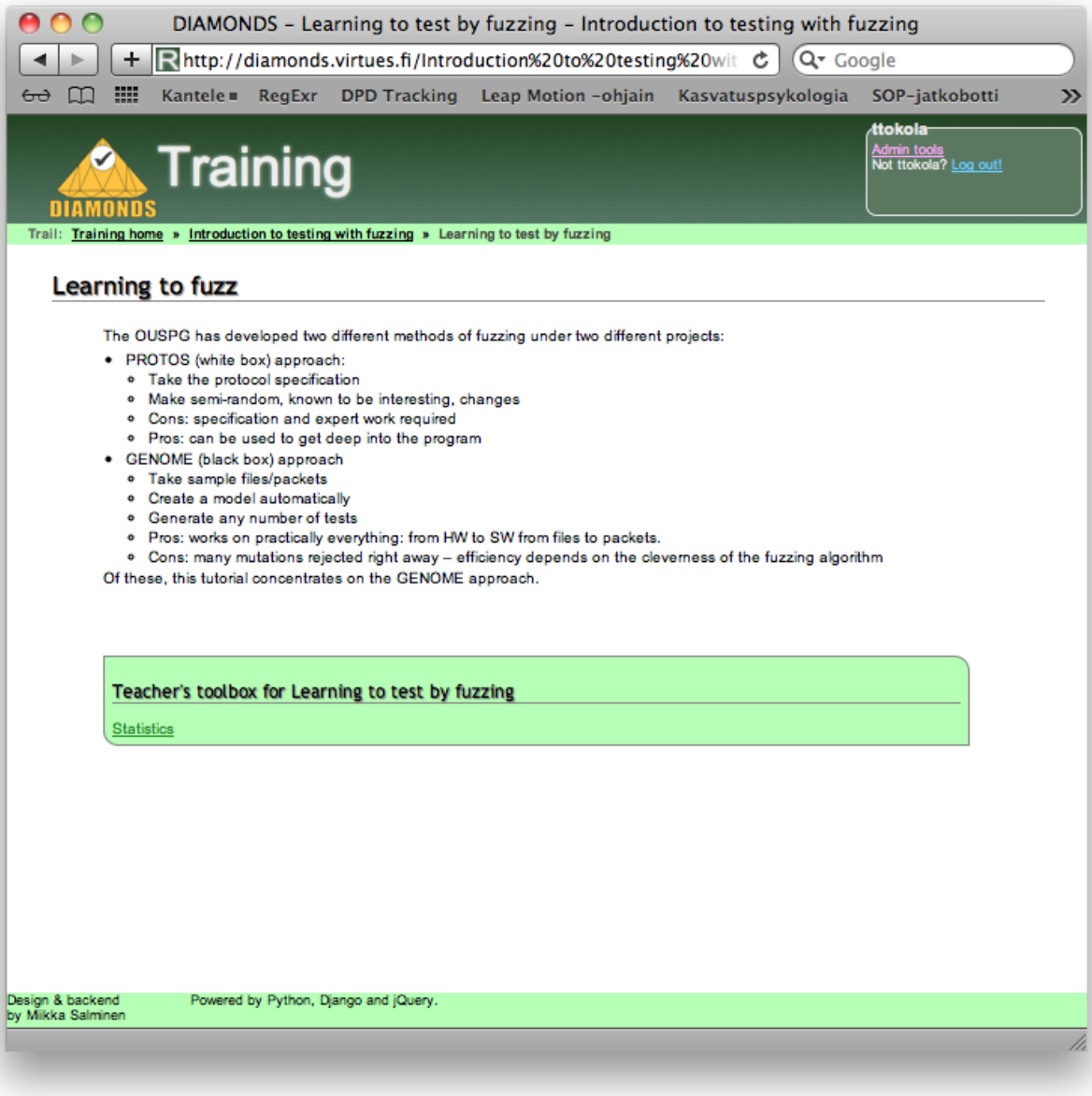

Figure 10. Content page from the "Introduction to testing with fuzzing "-training

3.2.1 Jyväskylä training seminar

The fuzzing training course implemented into the system was also held as a face-to-face training seminar in the Jyväskylä Polytechnic at the end of August 2012. This training was held to ensure the quality and the progression of the training material, and only marginal changes were made for the online version based on the feedback received. The training seminar, however, justified many of the training content decisions made. The training was a two-day event with altogether 8 hours of classroom working.

© Copyright DIAMONDS Consortium

4. ENVIRONMENT TRIALS

The training environment has been extensively tested in year 2012 to ensure, that the system performs as expected. This includes both performance tests (outlined in chapter 5) and usability tests and trials in production settings:

- First pilot in Oulu University programming summer course
- Second pilot in the same course in Autumn, with a larger amount of students

In addition to this, the material of the implemented fuzzing training has been demonstrated in a short course held in the Jyväskylä Polytechnic.

4.1 FIRST PILOT

In the two pilot courses held in the University of Oulu, the technical capabilities and the functionality of the system has been reified using two programming courses. The first one, a smaller course was held in August 2012. This first pilot was intended to try out the system in a smaller setting with a limited amount of users, to root out any maturity problems in the implemented system.

4.2 SECOND PILOT

The second course in Autumn 2012, which is still running at the moment of this writing, was a much larger course, and was used to stress the system a bit more to determine, whether the system would be responsive enough for the larger amount of concurrent users. While the amount of students was not massive compared to the amount of students using for example the Coursera.org online courses, the deadlines used meant that submissions often concentrated on a rather narrow timeframe, thus simulating the ability of the system to withstand higher loads. The environment of the DIAMONDS training system is expected to exhibit rather uniform load instead of the spikes often associated with online courses with deadlines.

© Copyright DIAMONDS Consortium

5. SYSTEM PERFORMANCE

In the adoption of prototype system to production use, it has been rather common, that unforeseen errors and problems arise from the production environment. These problems are usually associated with load levels that have surpassed the expectations.

In order to avoid experiencing these problems in the DIAMONDS training environment, the performance of the environment was tested using apachebench software. This work was done in connection with a Master's thesis that is being prepared in the department, due to be accepted by the end of the year 2012. The thesis outlines both the technical implementation and a variety of performance tests used to evaluate the system.

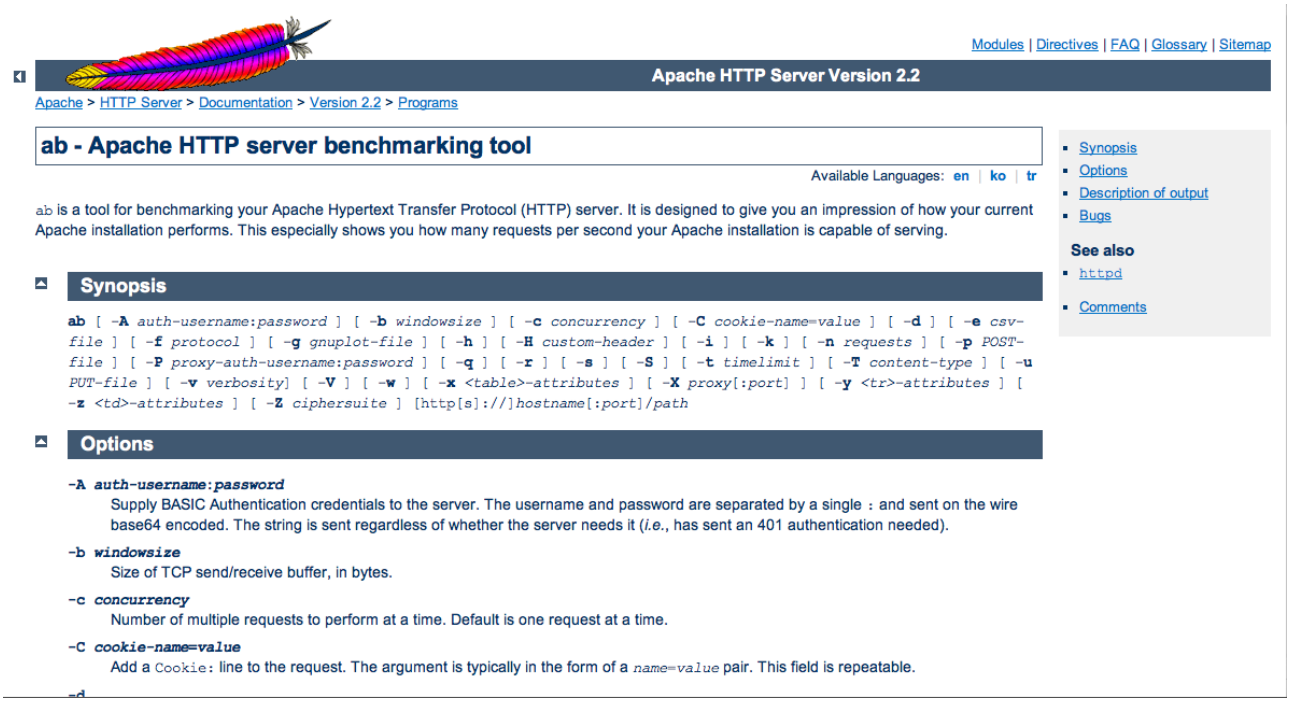

Figure 11. Apachebench software available at http://httpd.apache.org/docs/2.2/programs/ab.html

The performance capabilities of the system was analysed with two different pages, the front page with minimal content and a lecture page with large amount of content. The load levels that the system was able to handle, outlined in the following table, were deemed sufficient to handle the traffic loads expected of the system.

	Requests handled per second	Time to handle 100 000 requests
Front page	205.43 Hz	486 785 s
Lecture page	140.09 Hz	713 833 s

Table 2. System performance under load

© Copyright DIAMONDS Consortium

In more demanding tasks, in which users submit files to be compiled, run and evaluated by the system, the system performed understandably much slower, but as shown in the environment trials for the university courses (see subchapter 4.1), this was sufficient for moderately-sized courses at least.

For the DIAMONDS production environment the amount of file submission tasks is expected to be low, and as the scenario does not include deadlines, which could incur mass submissions at around the same time, the level shown in the next table should be quite sufficient.

	Requests handled per second	Time to handle 100 requests
File submission handling	1.35 Hz	73 907 s

Table 3. System performance under file submission tasks

© Copyright DIAMONDS Consortium

6. CONCLUSION

The system described in this document was developed from scratch in the DIAMONDS project to provide a platform that can be used for disseminating produced results. The system provides a view for the users for browsing trainings and contents and for completing exercises. In addition, authors of trainings have an interface that is to be used for creating the trainings, contents and for reviewing the trainings.

The system currently has two trainings available: one on how to create a training and the second on fuzzing testing.

© Copyright DIAMONDS Consortium