83962 Design Project in Telecommunications
@
Institute of Communications Engineering
Tampere University of Technology

Spring semester 2005

A Web Database for Self-Assessment

Final Project Report

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April 22nd 2005

***K**nowledge can be imparted in different ways. It's not only lectures and books where we get our knowledge from. More and more projects are nowadays dedicated to the development of web based learning systems. The aim of this project is to establish an integrative database of learning objects for the field of networks and protocols, incorporating the curricula of the project team members' home universities. A web application will give users the possibility to test their knowledge in the field of networks and protocols.*

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Glossary

Answer	In connection with the database and the catalogue of learning objects, answer refers to one choice or answer statement of a multiple choice question.
DTD	Document Type Definition, a set of declarations that exists to describe a class, or "type", of SGML or XML documents, in terms of constraints on the structure of those documents. [wiki]
ER	Entity Relationship, e.g. Entity Relationship Diagram
Field	In connection with the database and the catalogue of learning objects field refers here to a knowledge domain.
Goal	the state of affairs that a plan is intended to achieve and that (when achieved) terminates behavior intended to achieve it [wordref]
GLC	Global Learning Consortium
ICE	Institute of Communications Engineering
IMS	Information Management System
Internal User Interface	is the user interface for administrative issues, like updating the system, adding and removing problem tasks etc.
JKU	Johannes Kepler University, Linz
L(C)MS	Learning (Content) Management System
Learning Object	refers here to an entity of knowledge of the fields of networks and protocols which can be used for the learning tool to be developed. Based on the learning objects the problems will be specified. Learning Object is also referred to as object in this document.
Level	refers - in connection with the database and the catalogue of learning objects - to the level of study progress or rather the level of difficulty of a question. It can be also referred to as ‘stage’ in this document.
ODBC	Open DataBase Connectivity
PHP	PHP Hypertext Preprocessor

Problem	refers here to either a multiple choice or an open question on the field of networks and protocols.
Project	A set of related tasks, which have a specific goal or a set of specific goals, often requiring concerted effort. A project normally has strictly defined organization scheme, budget, and time schedule. It is often financed by one funding source.
Public User Interface	is the interface for the users of the learning system to select the learning topics and test their knowledge.
QTI	Question and Testing Interoperability
Question	In connection with the database and the catalogue of learning objects, Question is used as a synonym for Problem.
SCORM	Sharable Content Object Reference Model [aldnet]
SQL	Structured Query Language
Stage	means the level of study progress in the fields of networks and protocols and is also slightly comparable to the level of difficulty. Problems will be divided into different stages. It can be also referred to as 'level' in this document.
Subfield	In connection with the database and the catalogue of learning objects subfield refers here to an area of knowledge which is part of a knowledge domain (field).
TUT	Tampere University of Technology
UTA	University of Tampere
VBA	Visual Basic for Applications

1 Introduction

This document is the final report of a project. The project is about the development of a web based learning tool for testing the user's knowledge in the field of networks and protocols. It is – after the initial project plan [neprodoc] and the middle report – the third and concluding report of the project.

The purpose of this document is to provide an inside in the team's work during the project, describing the tasks that have been done, the difficulties that have been faced, the goals that have been reached and the results which are delivered together with this document to the client's representative. Furthermore it will be an initial source for projects that might follow later to continue or extend this project or integrate its result in a wider system.

1.1 Background

The project was initiated in the middle of January 2005 by the Institute of Communications Engineering (ICE) at Tampere University of Technology /Finland (TUT). Its aim was to produce a web based learner's tool for self-assessment in the field of networks and protocols up to the bachelor's level. The project was carried out by three students of TUT. A variety of projects are or have been dedicated to the development of web based learning tools and therefore studying and analyzing existing learning systems was advantageous, both for design and implementation of the system to be delivered by this project.

The system requirement is to have an integrated set of learning objects for the mentioned subject areas, collected from different departments at different universities as well as from other useful sources. The collected learning objects should be stored in a proper way in a database and are accessed by an application program. It should be a web based system and thus the application program will - together with the database - be located on a server and can simply be accessed from a remote site via the user's web browser.

1.2 Motivation

There are many already existing systems which provide the possibility for users to make self-assessment tests. There are already existing and complete tests offered to use via World Wide Web and the Internet. But their content is usually already set, the learning material is already included and the user just executes the test. In the case of this project the team tried to find a set of learning objects collected from the curricula the participants know from their home university. A major task was to refine a catalogue of learning objects that covers all courses of the involved universities in the field of networks and protocols.

For creating just new content there would not be a need to create a new application system, because there are already open source Learning (Content) Management Systems. Many of them provide a module for self-assessment tests. But the existing systems do not offer the possibility to structure the learning objects in a way that is suitable for our purpose. There was no system that allowed linking objects with several courses of different universities additional to separating them in subfields. No existing system could provide that up till now and no system could give the opportunity to select or shuffle the questions and learning objects in this specific way for the tests.

This is the reason why this project and probably the following projects are interesting for the client, teachers and students of the involved universities and even all people who deal with education in fields of networks and protocols.

2 Goals and Objectives

2.1 The importance of explicitly defining project goals

The difference between a goal and a dream is the written word.
Gene Donohue [dono]

We define 'project' as a set of related tasks, which have a specific goal or a set of specific goals. In turn, 'goal' can be understood as the state of affairs that a plan is intended to achieve and that, when achieved, terminates behavior intended to achieve it.

Citing the Project Definition, the general goal of this project, say its purpose, was to …

> *"… produce a learner's tool for self-assessment in the field of networks and protocols at bachelor's level. The tool will have a web interface for the students with multiple choice questions and other problems. Another interface is for teachers for updates. The main goal is the collection and organization of the learning objects. The actual storage system and the user interfaces will serve this purpose. They must still be carefully designed so as to facilitate conversion into some larger framework in a later project."* [neprodoc]

Even though it may sound for some people as if writing down dreams makes them become goals, the proverb in the beginning of this chapter clearly points out the meaningfulness of a well considered documentation of the goals for a project. There are two major reasons for this importance of analyzing project goals:

First, without agreeing on certain goals, it is hard, or rather, impossible to define the project requirements and tasks. Expectations, perceptions and imaginations can differ a lot, not solely between but also within the different stakeholder groups of a project. Hence, writing down goals can help to get a more collective understanding of the project itself. Second, it is hard to verify the achievement of goals, if they have not been declared explicitly.

There remains one more question: What, if the goals have changed while doing the project work? It is very normal, that goals (not just on an individual level) change in the course of a project, and they have also changed in this project. Regarding a very granular level of goals, it happens that goals disappear completely (they are not goal anymore) and new objectives arise out of the project work. Yet, when talking about a more general level of goals, their priority changes rather than their existence.

2.2 Analysis of the goals' achievement

A set of project goals, covering the project team's and client's as well as project management-related and deliverables-related goals, was made up in the beginning of this project work. The achievement of the goals set up in the initial Project Plan [neprodoc] will be analyzed in the following.

In this section we evaluate the attainment of the more general goals of the project, which - in the initial Project Plan - were divided according to their origin into 'project

team goals' and 'client goals'. This division does not mean that a client goal can not be a project team goal and vice versa. That's why we, as the project team, can also rate the achievement of the client goals, from our point of view.

The achievement of the goals will be rated

- as far as it can be verified already
- reflecting the project team's point of view
- using the five-level Goal Attainment Scale (GAS) [kierusk]
  - +2 much more than expected level of outcome
  - +1 more than expected level of outcome
  - 0 expected level of outcome
  - -1 less than expected level of outcome
  - -2 much less than expected level of outcome
- if necessary, giving reasons for the rating

2.2.1 Project team goals

Table 1: Project team goals

ID	Description	Attained			Comment
		Jukka	Konrad	Michael	
PT-01	Passing the course, getting the expected number of credit points.	-	-	-	1
PT-02	Getting a good grade.	-	-	-	1
PT-03	Experiencing and learning about good team work.	0	0	0	2
PT-04	Experiencing and learning about project management.	0	+1	+1	3
PT-05	Learning about new technologies and applying them in practice.	+2	+2	-1	4
PT-06	Getting insight into (different countries') curricula in the field of networks and protocols.	-1	-1	0	5
PT-07	Keeping up with final deadline (two project team members will leave Finland in may).	0	0	0	6

Comments:

1. [Jukka, Konrad, Michael] Acceptance of the project and grading depend on the course instructor and are not known yet.
2. [Konrad] The team play was ok. Sometimes people were motivated more, sometimes less. On the whole it was quite ok. Nearly +1.
   [Jukka] Even Michael broke his leg and couldn't work 100%, the team managed to overcome this. There weren't any argues or major disagreements. I agree with Konrad on nearly +1.
   [Michael] The working atmosphere was pleasant.
3. [Jukka] We've been doing a lot of team work assignments in different courses, which need a lot of management. That's why this didn't bring any new aspects on

project management but it was still good.
[Konrad] The project was a challenge, as the schedule was really tight. Attaining great importance to project management was necessary. We managed it quite well.
[Michael] We had to manage some challenging situations I have not expected before.

4. [Jukka] Web based programs were quite new to me, which is why this brought good experience on these areas. Also I got a sight to PHP and while gathering the objects and questions I learned a lot of new technical theory.
   [Konrad] The search for existing Learning Content Management Systems and applied technologies as well as the need for deciding on a technology brought many new insights. Being responsible for the web application, I got insight in applying the technologies MySQL and PHP.
   [Michael] Unfortunately I could not learn that much more about other technologies than expected. The main work was sorting, finding and organizing already known content instead of getting insight in other technologies that I did not know before.
5. [Jukka] We didn't bring our views to the project as from the point of our own country as we may should to have. On the other hand out point of views don't differ that much.
   [Konrad] As mainly Jukka and Micha worked on the learning objects catalogue, I did not get as much insight into the curricula of networks and protocols, as expected. Yet in my opinion, the decision on the division of the work was very reasonable and - altogether - good for the overall project outcome.
   [Michael] I could get the expected insight into other curricula.
6. [Jukka] Even it sometime looked doubtful we actually did keep up with the final deadline. We had a little bit of bad luck with the objects, but we managed to overcome this.
   [Konrad] We met all important milestone deadlines. Nearly surprising ;).
   [Michael] See Konrad's comment.

2.2.2 Client goals

Table 2: Client goals

ID	Description	Attained	Comment
CL-01	Getting a comprehensive and well structured set of learning objects in the field of networks and protocols.	-1	1
CL-02	System has required functionality.	0	2
CL-03	High level of usability of application.	-1	3
CL-04	The application is extendible.	0	4
CL-05	The system is well documented.	0	5
CL-06	The project reports are handed in on time.	0	6
CL-07	The product is delivered with no delays.	0	6

Comments:

1. Due to the tight project schedule it was not possible to make a perfectly comprehensive set of learning objects. This is *definitely* a very hard task anyway. Therefore, and because there were so many other requirements and tasks which had to be fulfilled, we think that we can on the whole be satisfied with the outcome. Though, we couldn't get done as many questions for the catalogue as initially expected. See also section
2. The application system, which is delivered on a compact disc (inclusive documentation, database design, SQL files) on the presentation day, has the functionality defined in the Informal Requirements Specification. [neprodoc]
3. The usability of the system is probably not the best. We tried to concentrate on the goal that the user can produce as few errors as possible. Yet the user interface could be made nicer and more self-explaining later on. See also section
4. The system is designed for a possible extension to multiple languages later on. Furthermore the database supports different fields of self-assessment, not just for one / the field of networks and protocols. Used technologies are well established and thus migration wouldn't be a big issue. See also sections
5. The PHP files are commented, furthermore the system is documented in this document and the documentation will also be delivered on the compact disc with the project deliverables. See also sections
6. The project reports were handed in on time and the project deliverables will be handed on to the client representative on presentation day.

3 Project management

3.1 Organizational structure and involved parties

The project team consists of three students currently doing their studies at TUT: Konrad Hartl, Jukka Luukkainen and Michael Nordhoff.

Konrad Hartl is an exchange student from Austria currently studying at the University of Tampere (UTA) and at TUT. At his home university in Linz Konrad's major is business informatics which can be seen as the studies on information systems and information management. Besides that he is mainly taking courses in fields of hypermedia, economics and foreign languages.

Jukka Luukkainen is a student from TUT. His major is communications engineering and some minors are programming and electronics. He has some experience on protocols in the field of designing and programming. Jukka is familiar with object-oriented programming and knows C++. This is his first project of this magnitude.

Michael Nordhoff studies Systems Engineering at his home university Universität Duisburg-Essen in Essen/Germany. His major is Network Systems Engineering; his minors are Software Systems Engineering and Business Systems Engineering. At the moment he also is an exchange student at the TUT and studies at the Department of Information Technology.

All three students carry out this project within the scope of the course 'Design Project in Telecommunications' which is held by the ICE at the Department of Information Technology of the TUT. K. Hartl is the speaker of the project team.

The project client is the ICE and the client representative and main contact person on the project is Jukka Koskinen, senior researcher and lecturer at the institute mentioned above.

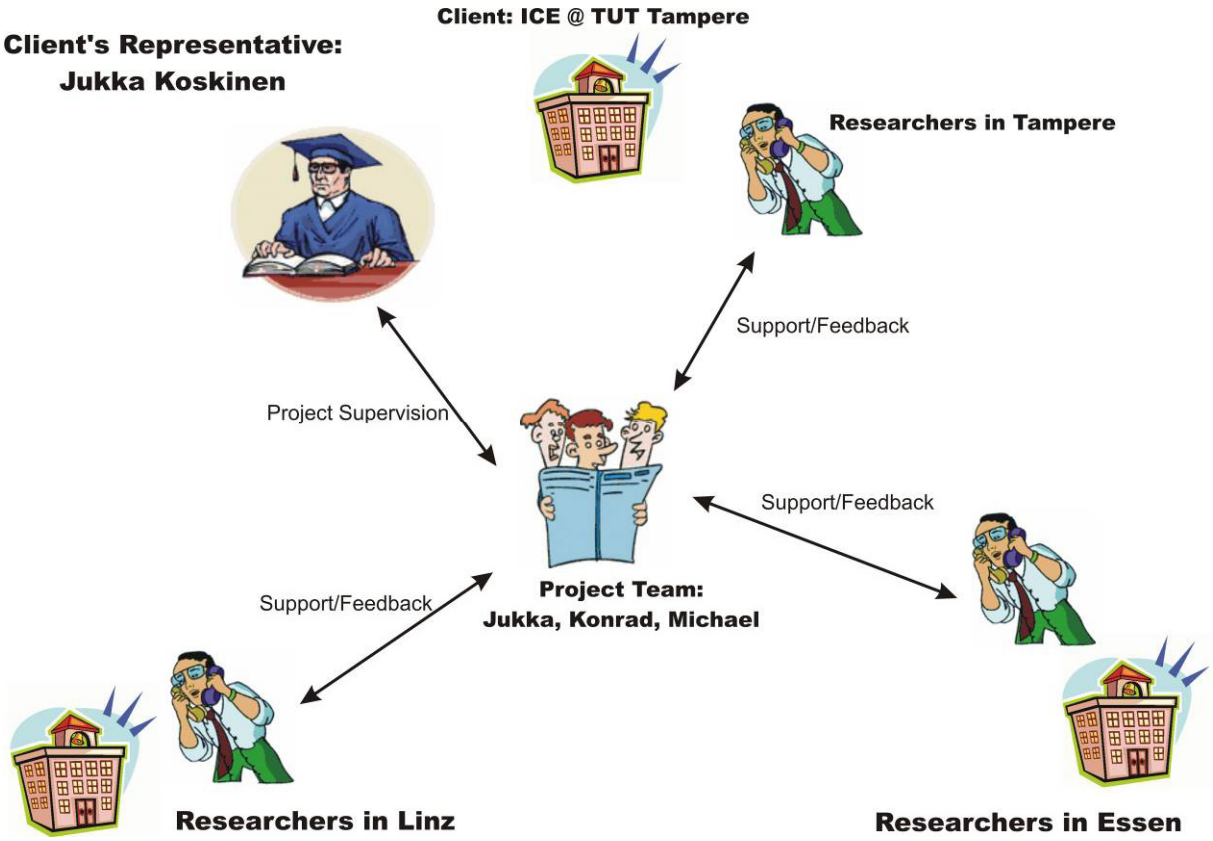

Figure 1: Organizational Structure

3.2 Communications and Meetings

A project usually comprises a number of different stakeholder groups, e.g. client, project team, project steering group, etc. As soon as people are working together, communication becomes one of the most decisive factors for the project success. Smooth ways of communication are essential for both, the communication between different stakeholder groups, and of course the communication within a stakeholder group (e.g. within the project team).

3.2.1 Communication with the client

The client for the project was the Institute of Communications Engineering (ICE) at the Tampere University of Technology (TUT); our client representative was Mr. Jukka Koskinen. As the client is responsible for the definition of the project, its goals and its deliverables, smooth communication between project team and the client is indispensable.

In this project, the communication with the client was quite open and informal. Three meetings were arranged, one for initiating the project (Jan 18th), the second one for reviewing the technology decision (Feb 8th) and the third one (Mar 4th) for reviewing the catalogue of learning objects as well as defining requirements and analyzing the project status. Besides the meetings, the usual way of communicating with the client was writing

emails. Furthermore we could address questions to him at the seminar meetings of this project.

The communication with the client, who is the project's course instructor at the same time, was very important for getting feedback on the intermediate results of the project work. He especially helped us with getting feedback on the catalogue of learning objects.

3.2.2 Communication within the Project Team

The project was done by a team of three people. Thus it would not have been possible for us to just agree on the project goals, tasks and deliverables with the client representative. The more people are working together, the harder it becomes to coordinate their work. Although our three-man project team can not yet be considered as a big project team, the importance of managing the task of coordination was essential for this project.

Project team meetings

When starting the project in January 2005 the project team members agreed on having regular weekly project meetings. The meetings were mainly intended for coordination purposes. Depending on the tasks the project team workers were currently working on, the meetings lasted from 45 minutes to 4.5 hours. The weekday for the regular weekly meeting changed several times during this project work, due to changing schedules of the team members.

Usually the meetings started with a summary of each team member, in which the work, which was done since the last project meeting, was presented to the colleagues. In the meetings we discussed difficulties and problems which we were facing when doing the project work and tried to solve them. The meetings ended with the analysis of the tasks to be done next and their assignment to the respective project team members.

During each meeting we took notes. The purpose of those notes was, to summarize the outcome of the meetings and reflect the current project status both, for the project team members themselves as well as for other project stakeholders. Therefore, the so-called meeting minutes were published on the project information website. [nepro]
Additionally to the regular project meetings, the project team came together when there was the need for it, e.g. before delivering milestone-documents.

On the whole, the project team came together 20 times during the time from January 18th to April 11th. At the main part of these meetings, all three project team members were present. On the whole, the 20 meetings lasted 45 hours, which makes an average of more than 2 hours per meeting.

Other communication within the project team

Additionally to the face to face communication at the project meetings, the project team members used to communicate with common means of communication, say email and mobile phone.

3.2.3 Communication with other stakeholders

Besides the meetings with the client and the internal project team meetings, we arranged one more meeting with Mr. Lauri Pohjanen from the Hypermedia Laboratory of TUT. He introduced us into some existing Learning Management Systems (LMSs) and Learning Content Management Systems (LCMSs), which could be useful for our project work.

We have set a high value on the Project Public Relations. Hence, one more means of communication with stakeholders of the project was the project information website [nepro]. Besides the meeting minutes, all milestone documents of this project can be downloaded from there. Furthermore a web-form on the site provided the possibility to send an email to all project team members.

3.3 Risks

3.3.1 Background of projects risk control

Before the project was started the project team had to take into a consideration the possible adversities that could have brought differences to the plan. A risk analysis was made in the initial Project Plan [neprodoc], where risks were categorized into four different areas:

Organizational risks:
The risks in this category were the tight schedule, which was set for the project. The possible affecting variables were sudden sickness or a loss of a team member. Also the fact that the two team members have to leave from the country in end of the semester was a possible parameter for this risk to happen.

Personnel risks:
The capabilities of the team members were analyzed and then categorized as a risk. The project team was prepared for the possibility that some of the areas in the project could have been technically overwhelming for the project team's skills and knowledge and the tight schedule would have not give enough time to learn the new areas. Also the possibility of losing the interest on the project by the team members and the used language among team members was taken into consideration.

Estimation risks:
The estimated time and resources that were planned to be spent into the project were taken with caution. False estimations would have without doubt caused an error to the time schedule.

Equipment risks:
The project team did not have many technical resources, but the possible failure of the tools or sudden need for new ones that were not in estimation plan was considered as a risk. These risks could have had serious impacts on both of the major project variables: time and funding.

With this analysis a risk control plan was made and probability, impact variables and mitigations were estimated.

Table 3: Identified risks

Risk	Probability	Impact	Probability mitigation
Organizational Risk	Trivial	High	Keeping up with the deadlines so the project will be ready before end of semester. Also keeping up with the interest among members.
Personnel Risk	Moderate	Moderate	Knowing the limits and capabilities of each team member and not tasking them too much.
Estimation Risk	Low	Moderate	Understanding the true costs and requirements of the projects and not underestimating them.
Equipment Risk	Low	Moderate	Careful planning in the beginning. Understanding the features of the project entirely.

3.3.2 Occurred risks and impact

None of the risks happened totally. However some of them occurred partly and had an impact on the project. As these risks did not happen entirely the impacts were not as hard as estimated in risk analysis of Table 3.

Organizational risks:
In the beginning of February one of the team members injured his leg. Because of this he had to stay indoors and could not work as much as he wanted. This was compensated by keeping some of the meetings at his place, so he would not have to move his injured leg. However the most important deadlines were met and the project was completed before two members of the project team had to leave the country.

Personnel risks:
The technical capabilities of the team members were sufficient for the project. However, the project team had problems with collecting of objects because none of the team members had previous experience on this kind of a work. The client was not completely satisfied with the outcome of the object catalogue so the project team had to continue the work with the objects after the delivering date of the catalogue. This caused some extra work hours which were done at the same time as designing part of the project (See Schedule). However the interest on the project was never lost and the final deadline was met, so this risk occurred just partly.

Estimation risks:
Estimation risks did not take place even the project team had problems with collecting objects, which was categorized to personnel risks. The estimations on the amount of time and resources to be spent were correct.

Equipment risks:
The two laptops were sufficient for this project. There was no need for hardware or software that would have changed the funding. If there would have been a need for extra

equipment like new commercial software that would have been superior for this project, it would have changed the project funding estimation and outcome all together.

Table 4: Occurred risks

Risk	Estimated Probability	Estimated Impact	Realized	Realized Impact
Organizational Risk	Trivial	High	Partly	Low
Personnel Risk	Moderate	Moderate	Partly	Moderate
Estimation Risk	Low	Moderate	False	-
Equipment Risk	Low	Moderate	False	-

3.3.3 Summary of risk analysis

Some of the risks that the project team was prepared for did actually occur. As they were analyzed the team could response to them quickly and thus could lower the effect of the impact.

Even that without the analysis, the occurred misfortunes would have had a more tremendous impact and possibly a complete stop for the project, they had an effect on the quality of the outcome.

4 Project Phases

4.1 Initial Project Planning / Preparations

The project team got the initial mail from the client's representative in the middle of January. The project specification was attached. The team met the same week for the first time and studied the specification and the guidelines and had to discuss about the execution of the project. In this meeting the team had to get familiar with the goals, the tasks and general procedure of working for this project. The team first agreed that there is a need to meet regularly at the TUT to discuss results and the current state of affairs, further proceeding and about problems and how to solve them.

Especially in the beginning the team met the client's representative to verify the elaborated goals and tasks and to get further information about them. For working out the initial project plan everyone got one part of it for creating. The team found out that it is wise to discuss and prepare some things in a group but to work out certain parts on one's own. Communication during the elaboration was necessary. Goals and tasks were defined; a time-table was created. Additionally to the written initial project plan the team had to prepare a presentation for the seminar.

4.2 Searching for existing systems and technologies

The next milestone after the delivery of the Project Plan and the start presentation was the decision on the technology, which is to be used for the implementation of the self-assessment tool. As the project tasks of developing the catalogue of learning objects, designing the database and making up questions for the learning objects seemed already quite heavy to us, we decided to look for existing web-based systems, which could be used for storing and organizing the learning objects in a proper way and provide the possibility for self assessment in the form of a quiz-tool with multiple choice or similar questions.

4.2.1 Analyzing existing systems

Our client advised us to consult Lauri Pohjanen from the Hypermedia Laboratory of TUT. At the arranged meeting, Mr Pohjanen showed us some L(C)MSs which are in use at TUT, e.g. MOODLE and MASO. Yet unfortunately he could not present us a system which meets the requirements of our project.

Upon the meeting, the project team members went on with looking for useful open source systems that could cover our needs. In doing so, we analyzed a number of different L(C)MSs, amongst others:

- ATutor [atutor]
- Bazaar [bazaar]
- Claroline [claroline]
- ILIAS [ilias]
- MOODLE [moodle]

Some of the systems seemed to be really powerful, incorporating also self-assessment- or quiz tools. Our 'favorites' were ILIAS and MOODLE. Yet they did not really provide means for an organization of Learning Objects as we were looking for.

Hence, upon the feedback and comments of our client, we decided to implement the system on our own. Yet the task of looking for existing L(C)MSs was useful as we got insight into the way of how they organize the learning content and which standards they observe.

4.2.2 Analyzing existing standards

One of the major aims of the client and the project team was the compatibility of the self-assessment tool to existing systems. It would be useful, if the database would fit in a way into existing LMSs and LCMSs. The advantages were clear: The content of the database could be integrated or added into other systems. To reach the best independence from certain systems and gain the highest flexibility, it is important to conform to a suitable standard. Unfortunately in the field of LMSs and LCMSs there is not just one perfect standard.

There are many projects and groups that develop in this field. A complex open source framework for LMSs and LCMSs is "Sharable Content Object Reference Model" (SCORM) from "Advanced Distributed Learning" [adlnet]. This seems to be quite accepted and many system vendors and developing communities attract with its compatibility, although many L(C)MSs do not implement it completely. It seems to be hard to meet and

implement all the specified requirements and gain required functionality at the same time. It is a very complex collection of specifications and was maybe not suitable for building a self-assessment system. The system's leaning objects would not be courses with course material itself; they would basically be any kind of questions and answers with a certain structure.

For such items there are special standards and quasi-standards, some of them from proprietary systems. Last ones are for example from Blackboard [blackboard], WebCT [webct], eCollege [ecollege] and others. Due to our previous decision to deal with open source systems, we decided not to adapt our system to this kind of standards.

Rather the project team planned to build its own system and put the main stress to the task of collecting and organizing the learning objects. It seemed not that important to meet a complete and complex L(C)MS standard. Nevertheless the goal of our project also said that the system "must still be carefully designed so as to facilitate conversion into some larger framework in a later project". When making our technology decision, we would have to consider this.

4.3 Deciding on information system and used technologies

The requirement of the possibility for a conversion of the self-assessment tool into some larger framework called for using the same technologies as they are used by the system where it would be integrated later on. Thus we analyzed some of the already explored LCMSs for their used technologies.

We found that both, MOODLE and ILIAS [weblearning] as well as other LCMS systems used the combination of Apache [apache] as a web server, MySQL [mysql] as database server and PHP [php] as scripting language. And so we looked for more information about this technology combination. We found that

- The combination of Apache, MySQL, and PHP is one of the most popular web site environments. It is commonly referred to as AMP for Apache, MySQL, and PHP [amp]
- AMP is used by many systems, also for many open source L(C)MS.
- All three technologies are open source and consequently cost-effective.
- PHP is quite fast, compared for example to JAVA.
- MySQL is the world's most popular open source database (according to Wikipedia and other sources, more than 4 million installations, 35.000 downloads per day) [wiki].
- Apache server is open source, the by far most popular server in the world (more than 67% of the web sites on the Internet are using Apache [netcraft]
- Thus using these technologies would make it easier to integrate the learning objects database into the existing frameworks of the DBMSs ILIAS and MOODLE, which were our favorite systems. It would for example be possible then to modify the existing quiz/self-assessment tools of the systems appropriately.
- Furthermore, as for the scope of our project, it was not yet that important to have a very impressive user interface. Rather, presenting the questions and some pictures on a webpage would do. The actual integration of the database into the existing framework or system would e.g. be scope of a subsequent project.

Hence, because of the stated reasons, we decided to use the combination of Apache web server, MySQL database server and PHP.

4.4 Collecting Objects and building catalogue

4.4.1 Background for collecting objects

The need for these objects was based on the requirement of perceiving the area of networks and protocols. Without these objects it would have been very difficult to cover the whole technical area and questions would have been randomly made all around the topics. This is why the collection of objects was most crucial part of the project and had a high priority.

4.4.2 Collection of objects

The collection of objects started after the decision on information system in 4th of February (see Deciding on information system and used technologies). The project team had a meeting with the client on 8th of February and an internal meeting on February 11th about the collection of objects (see Project Management -> Communications and Meetings).

In the meeting with the client the project team was advised to categorize the area of networks and protocols into subfields which should ease and clarify the collection of objects itself. In the next meeting on 11th a rough sketch of the subfields was made. In this meeting it was noted that dividing the area into subfields was not an easy task. By 25th of February the fields were divided into 11 different subfields and objects were collected for these subfields by using the material the team had on the courses and using the information in the Internet. After this the first version of the catalogue was sent to the client.

On 4th of March the project team and client representative had a meeting about the objects, where new insights were revealed. Some of the objects needed to be renamed and the subfields needed to be reformed. After this the project team focused on reforming the catalogue. Because the schedule was tight the project team had to do this while working on other areas of the project like user interfaces and database.

On 28th of March the reform of the catalogue was still incomplete, mostly because the team members found it very hard to break the old form and reorganize the objects to the new subfields. There were few online tutorials about collecting learning objects but because time was running short the project team decided to concentrate on questions and tried to modify the catalogue while doing so. The catalogue changed slightly after the making of the questions and on 10th of April the catalogue was in its final form. (see Deliverables -> Collection of Learning objects)

4.4.3 Summary of Collection of objects

The collection of objects and building of the catalogue was started on 4th of February as planned in the time schedule. It was on 11th decided to categorize the area into subfields so the collection of objects would go in a reasonable way. Objects were gathered and by 4th of March the first draft were delivered. After this the names of the object and the form of the catalogue changed all to the 11th of April, when the catalogue was brought to its final version.

4.5 Allocation questions to the objects

4.5.1 Background for questions allocation

The questions are the main point of the project, which is why the learning objects were gathered in the first place. With these objects is was possible to cover the whole area of networks and protocols in a sensible way. To maximize the total use of the objects it was necessary to assign multiple questions to one object.

4.5.2 Generating the questions

After the first draft of the catalogue of learning objects, it was possible to start to form multiple choice questions based on the collected objects. A questions template was made for this purpose.

Table 5: Questions template

ID		
Field		
Object		
QUESTION		
Q-Image		
Solution		
S-Image		
Level		
Points		
A 1		
A 2		
A 3		
A 4		
A 5		

In this template the following fields can be seen: ID, Field, Object, Question, Q-image, Solution, S-Image, Level, Points and A1 – A5

Table 6: Fields of the question template

Field	Explanation
ID	Identification number of the question in this document
Field	The subfield, which the question belongs to.
Object	The object, the question is assigned to
Question	The question string itself.
Q-Image	A possible picture or image that is shown with the question. Not mandatory
Solution	A possible solution or explanation for the questions, which is shown after the quiz, has been done. Not mandatory
S-Image	A possible picture or image that is show with solution. Not mandatory.
Level	The level of difficulty of the question. [1-3]
Points	The number of points gained if the answer is correct. [1-5]
A1 – A5	5 options that can be given as an answer for the question. They are marked by true [T] or false [F].

After deciding the form of the question template and the necessary fields for it, the project team agreed to make at least 3 questions per an object.
The generation of the questions began and it was quickly noted that this was not an easy task.

The questions needed to be in English, but most of the material that the team had was in Finnish and German, so the translation brought few difficulties. Also making the questions for some of the objects were quite hard and because the time schedule was very tight, few of the objects were left out from the question making. Also the question generating was not in the planned time schedule so the project team had to work with them at the same time as the other phases of the project. The final catalogue of questions was finished on 12th of April (see Appendix -> Catalogue of questions).

4.5.3 Summary of generating the questions

The making of the questions started on 15th of March and was finished on 12th of April. The questions were based on the catalogue of learning objects (see Deliverables -> Collection of Learning objects) and the aim was to generate 3 questions per on object. Even the project team had some troubles in the collection process; it succeeded to create an acceptable catalogue of questions (see Appendix -> Catalogue of questions) that the system can work with.

4.6 Designing Database

Soon after our technology decision we started to design the database for the application system. For the database design we were considering the requirements stated in the initial project definition [neprodoc]. They claim for

- Learning Objects with name and short description
- Each learning object should be associated with a couple of multiple choice questions
- Existing courses at different institutes
- Problem statements that are relevant to some sub-goal of the courses
- Possible sequencing of the objects within a moderate number of stages
- Mapping from a given set of courses or a given stage

Based on these requirements we started to design the database. The database was refined several times upon our project team meetings and upon one meeting with the client representative.

The tool used for designing the database was 'DeZign for Databases' of the company DATANAMIC [datanamic] which can be evaluated for free for 30 days. It uses modified Entity Relationship (ER) notation (mixture between ER and database diagram) and is able to generate SQL files out of the diagrams, which incorporate the statements for setting up the whole database.

One important requirement, which was made up during the database design, is the support for multiple languages. Thus for all table columns which represent textual information (string/varchar), a separate language table was established, which refers to the rows of the original table by using a foreign key.

4.7 Designing Application and User Interface

4.7.1 Designing the Application

In our heads the task of - as we refer to it - 'designing the application' actually started in the very beginning of the project, i.e. as soon as we knew that we had. Our idea of the application design evolved, as the project went on and the requirements for the web application got clearer.

Requirements

Functional Requirements

The functionalities which could possibly be incorporated by a web application for self-assessment are numerous. Yet, within the scope of the tight project schedule, it was not possible to deliver a fully featured web application. For this reason, the functionalities incorporated in the web application delivered by this project were restricted in the 'Informal Requirements Specification' [neprodoc], which was handed on to the client on March 2nd. According to it, the web application would be delivered with the following functionality

- User has the possibility to choose the area of self-assessment by specifying
    - Field(s) from a list of available fields (default: all fields)
    - Subfield(s) from a list of available subfields (default: all fields)
    - Course(s) from a list of available courses (default: all courses)
    - Level(s) from a list of available levels (default: all levels)
    - Learning Object(s) from a list of available learning objects (default: all learning objects)
- User can see the number of questions given his selection of fields, subfields, etc.
- User has the possibility to choose kind of assessment
    - answering of all questions belonging to the chosen category

    - random selection of questions belonging to the chosen category, where users can choose, how many questions they want to answer
- User has the possibility to do the self assessment
- Answer the questions belonging to the chosen area and in the chosen assessment form.

- User has the possibility to add learning objects
- User has the possibility to add questions (inclusive answers)

Non-functional requirements

Non-functional requirements for the web application were already defined in the initial Project Plan [neprodoc]. Additionally in the Requirements Specification [neprodoc] the following non-functional requirements were added:

- Browser compatibility: The system must be compatible with Internet Explorer 5.0 and higher and Gecko 1.5 and higher.
- The system must be implemented in a way so that it can later on be easily extended for multiple languages usage. This is valid both for the application program and the database of learning objects.
- The system must be implemented in a way so that it can later on be easily extended for concurrent user sessions.

Architecture

Designing the architecture of the system arose out of learning PHP. We did not know how to use it in the beginning of the project, so we had to begin from scratch studying the language. It turned out that learning PHP is not really hard, yet it still took a lot of time.

The more insight we gained into how to work with PHP, the concreter became our idea of the system architecture. Please refer to section Deliverables for a more detailed description of the realized system architecture.

4.7.2 Designing User Interface

The design of the user interface started on 4th of February. In the meeting of 8th of February it was decided to do two interfaces: public and administrator interface. For the public interface it was needed to build some kind of a tool so the user could choose from multiple choices the options he wants.

An idea was gained from a Nokia recruiting webpage [nokia] (Figure 2), where the choices were categorized into fields. These fields would respond to changes that happen in other field. This form was suitable for the project's system too, so on 6th of March a design (see Figure 3: User Interface Design for the Public Users) based on the Nokia recruiting webpage was created. This design had similar fields as the referred webpage, which would respond to changes in the other fields.

Also we needed an interface for administrative purposes, where questions, objects, universities etc. could be added, removed and edited. A design (see Figure 4: User Interface Design for the Administrators) for this interface was created right after the public user interface.

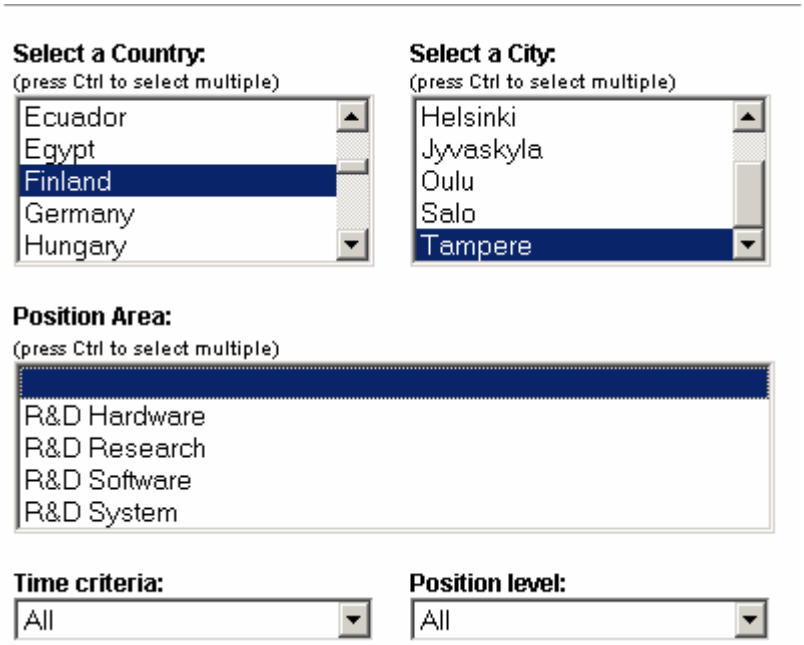

Figure 2: Example website

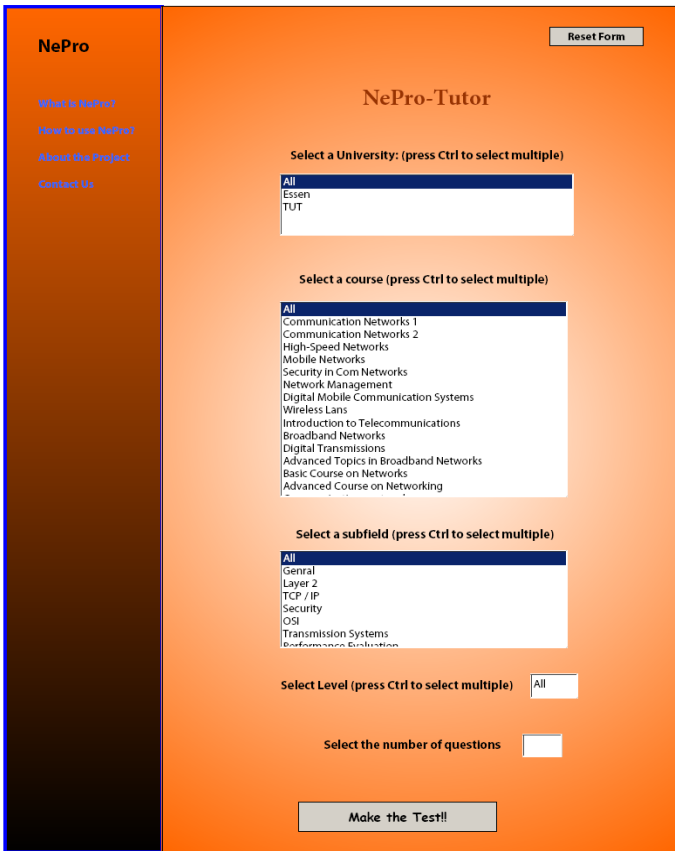

Figure 3: User interface sketch for students

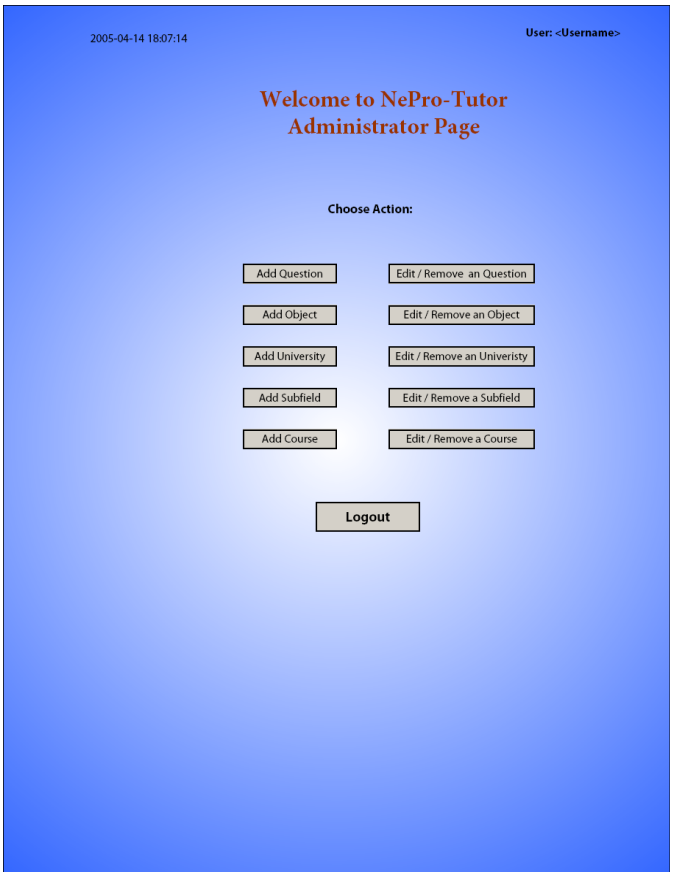

Figure 4: User interface sketch for administrators

4.8 Implementing Database

Implementing the database started already in February. On our personal computer we installed the program EasyPHP [easyphp], which incorporates the technologies Apache, MySQL and PHP. Due to the fact, that our database design program DeZign for databases supports the generation of SQL files out of the drawn database diagram, the implementation process of the database itself was not a big issue.

Yet there were some major problems. For implementing the web application it would have been very useful to have views defined in the database. We were originally planning to use views for presenting data from and inserting data into the database, yet only after that we had to realize that the current certified production-ready release of MySQL (4.1) database system does not yet support views.

Thus it was initially tried to set up the Beta version of the 5.02 MySQL release, which should support views, as it can be expected, that views will be essential and very frequently used, also with the MySQL server. Yet after couple of hours of unsuccessful tries, this undertaking was stopped and the decision for not using views was come.

4.9 Implementing Application / User Interface

The actual implementation phase for the web application started in the end of March. The functionalities for doing a quiz were implemented by April 13th. The administrative pages for inserting new learning objects and questions into the database are being implemented by April 20th.

4.10 Testing / Debugging

Testing was performed permanently by the programmer during the implementation phases. Furthermore the project team members have been testing the correct functionality of the system.

4.11 Final Report and Presentation

One main result of the team's project is the final report. As planned before everyone collected the material one found, used and produced during the whole project. This included for instance the meeting minutes, some e-mails with description the members exchanged about insights they got during researching, e-mails between the client's representative and the group, for example about the technology decision and their arguments, etc. This collection is the raw material for writing the final report.

The team met for starting to write the final report. The members met twice to work out a suitable structure for the document. The decision was made that the main part of the document should be divided into the sections like 'Introduction', 'Goals and Objectives', 'Project Management', 'Phases', 'Schedule' and 'Results'. After a more sophisticated subdivision the team determined exactly the content of each part and who is responsible for each one.

During the report writing parts of the documents needed to be exchanged, because sometimes other parts needed to be based on them. Collecting terms for the glossary was everyone's task.

The preparations of the presentation have not been started yet. This will happen in the last week. Mainly the most important results of the final report need to be presented in a suitable way and the results need to be shown.

5 Schedule

Like every project also this one needed to be scheduled. Most of the milestones were deadlines given by the client's representative: the deliveries of the three reports, the delivery of the learning object catalogue and also the presentations which were set to certain seminar's meetings. In this fixed framework the team has put their tasks and some other minor milestones for internal usage. Also the workload needed to be planed. The aim was to work 140 hours each to meet the requirement for the seminar. The project should have been finished after this workload.

Table 7 shows the planned workload for each person and task and the planned and realized finishing of each task. The red marked dates differ to the planned one in a relevant way. Red marked amount of hours that were performed differ to the planned in a relevant way (i.e.: performed workload differs to the planned one by 25% or more *and* 2 hours or more). Task 14 and 15 was not in the plan at all: "Collecting questions" was not clearly allocated to the other planned tasks. The team decided to create an extra task for this purpose. Also the work for creating and maintaining the project information webpage is displayed as an additional task.

Table 7: Schedule planned and realized

Task / Milestone		Date		Hours Workload					
ID	Title	(planned/realized)		**Jukka** (planned/perfor.)		**Konrad** (planned/perfor.)		**Michael** (planned/perfor.)	
(a)	Projcet Start	Jan 14	Jan 14						
(1)	Initial Project Plan	Jan 21	Jan 22	6	9	8	17	6	8
(b)	Delivering Initial Project Plan	Jan 21	Jan 22						
(2)	Preparations	Jan 28	Jan 28	8	10	10	18	5	6
(c)	Presentation Initial Project Plan	Jan 28	Jan 28	1	1	1	1	1	1
(3)	Searching for Existing Systems and Technologies	Feb 04	Feb 05	15	14	13	16	17	23
(d)	Decision on Information System	Feb 04	Feb 05						
(4)	Collecting Objects and Building Catalog	Feb 25	Apr.10	40	58	40	22	40	45
(e)	Delivering a Catalog of Courses and Learning Objects	Feb 25	Mar 04						
(5)	Designing Database	Mar 04	Mar 04				14	8	2
(6)	Designing Application System	Mar 04	Mar 20			10	10		
(7)	Designing User interfaces	Mar 04	Mar 20	12	13		2		
(f)	Delivering Middle Report	Mar 04	Mar 04						
(8)	Implementing Database	Mar 25	Apr 03				15	30	12
(9)	Implementing Application System	Apr 08	Apr 20			20	50		
(10)	Implementing User Interfaces	Apr 08	Apr 20	25	4				
(11)	Testing and Debugging	Apr 15	Apr 20	15	0	20	10	10	0
(12)	Writing Documentation	Apr 15	Apr 15	10	10	10	12	15	21
(g)	Delivering Final Report	Apr 15	Apr 15						
(13)	Preparing Final Presentation	Apr 22	Apr 22	7	7	7	11	7	7
(h)	Final Presentation	Apr 22	Apr 22	1	1	1	1	1	1
(14)	add.: Collecting questions		Apr.10		43				23
(15)	add:: Creating & updating project info webpage		Apr 22				16		
		SUM		140	170	140	215	140	149

(1) Initial Project Plan - the team members discuss the execution of the project work, the goals, tasks and all other concerns you can find in this initial project plan.

(2) Preparations - the team has to organize themselves, start to contact important people and institutes, search for information and prepare the initial presentation.

(3) Searching for Existing Systems and Technologies - searching for already existing systems, especially for web-based open source ones. The team has to analyze and evaluating the found systems.

(4) Collection Objects and Building Catalogue - the team needs to consult teachers, lecturers, professors and researchers of the different departments and institutes, analyze their curricula, compare them with each other as well as with standardized curricula, evaluate them and make decisions on what objects should be taken into account. The object must be put in the suitable courses and stages.

(5) Design Database - the team has to design a (relational) database.

(6) Design Application System - the team has to design the software system, the application that is running on the server and interoperates with the database and the remote clients.

(7) Designing User Interfaces - the (graphical) user interfaces need to be designed. The team has to design the interface for people who use this system for self-assessment and for people who maintain and update the catalog, enter new courses and objects, and checking results.

(8) Implementing Database - the team has to build the designed database and enter the records.

(9) Implementing Application System - the team has to implement the designed server-side application.

(10) Implementing User Interfaces - the team has to implement the user interfaces for using and maintaining the system.

(11) Testing and Debugging - the entire system needs to be tested. Faults need to be detected and eliminated.

(12) Writing Documentation - the whole project has to be documented. This includes the report of the performance of the project and a documentation of the result.

(13) Preparing Final Presentation - all results need to be presented for the other seminar participants and client representatives. This has to be prepared and per-formed.

(14) Questions with answers need to be collected or created. The questions and answers need additionally to be allocated to the right objects.

(15) The team decided to create a web page for information about the project and the state of affairs. Additionally it needs to be updated and maintained.

Obviously the team could not meet the exact workload target. Some tasks needed much more time. Also the responsibilities changed at some points. But the team could meet all the important deadlines more or less. The following time schedule shows the planned periods of the tasks and their milestones and deadlines. All important changes are marked in red: some tasks periods were extended and task (14) and (15) were added.

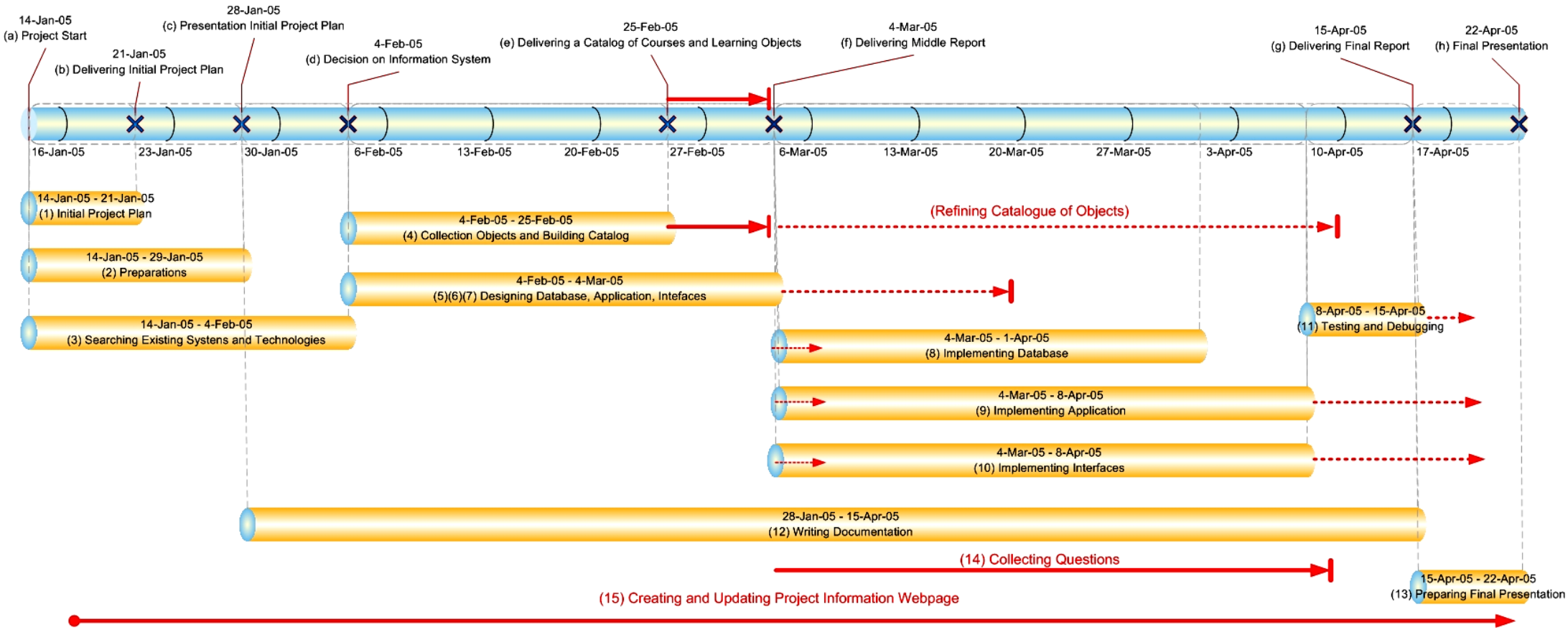

Figure 5: Schedule planned and realized

6 Outcome

6.1 Catalogue of Learning Objects

The final catalogue of learning objects was completed on 10th of April. In this final catalogue, it had 11 subfields and 194 objects. The objects arose out of 20 different courses from 3 universities.

The main goal in the creation of the catalogue was not to make every object and subfield exactly the same size but to cover the whole area of network and protocols. Even the results were not as good as expected, a workable catalogue was delivered. Most of the difficulties were concerning the size and naming of the objects and because of the tight schedule there was not any time to fix these errors.

The collection of subfields and learning objects was made up mainly, based on the collected course material of the team members' home universities. A list of the courses and their allocation to the three universities 'Tampere University of Technology' (TUT), 'University of Essen' (Essen) and 'Johannes Kepler University, Linz' (JKU) can be found in the appendix.

Analyzing the field of Networks and Protocols by looking at the contents of teaching in the different courses resulted in the allocation of the following subfields:

- General
- GMS/UTMS/3G
- ISDN/ATM
- Layer 2
- Open System Interconnection
- Other mobile systems
- Performance Evaluation
- Quality of Service
- Security of Communication Networks
- TCP/IP
- Transmission Systems

For each of those subfields a number of learning objects was identified. Their listings can be found in the appendix (section 9.2) for each allocated subfield.

6.2 Questions

Making up questions was done upon compiling the catalogue of learning objects. Questions are allocated to learning objects specified in the catalogue. The collection of questions can be found in section 9.3 of the appendix.

6.3 Database

The database, as it is set up by this project, comprises 28 tables. 19 out of the 28 tables are - as we call them - 'language resource tables', which were implemented to allow a possible extension of the system to a multilingual application later on.

The 9 basic tables, which represent the actual database, are:

- university - table refers to a university where learning content of the database is taught and holds name, city and country of the university.
- course - table refers to a course held at a university and holds name and description of the course, the year in which it took place and the institute and university, where the course was held.
- field - table refers to a general knowledge domain (e.g. Networks and Protocols, Economics) and holds the field name and a description of the field.
- subfield - table refers to a subsection of a general knowledge domain (field) and holds the name and description of the sub area as well as the reference to the field it is assigned to.
- object - table refers to an element which is a further subdivision of a subfield. This element is also referred to as 'learning object'. Table holds name, shortcut and description of the object as well as the reference to the subfield it belongs to.
- course_object - table is used for the mapping between courses and learning objects. It holds pairs of course-IDs and object-Ids.
- level - table refers to the level of study progress or level of difficulty a question can be assigned to. It holds the name of the level and its description.
- question - table holds the information for representing a question for doing self-assessment. It holds the question type, its task specification and task solution, images for illustration of problems and solutions as well as the object and level the question belongs to.
- answer - table refers to an answer for a certain question and holds the answer statement, its verity and a comment for the answer and refers to the question it belongs to.

Figure 6 shows the simplified Entity Relationship (ER) diagram of the database. Please refer to the appendix (section 9.4) for a closer look into the detailed diagram, as the database is implemented.

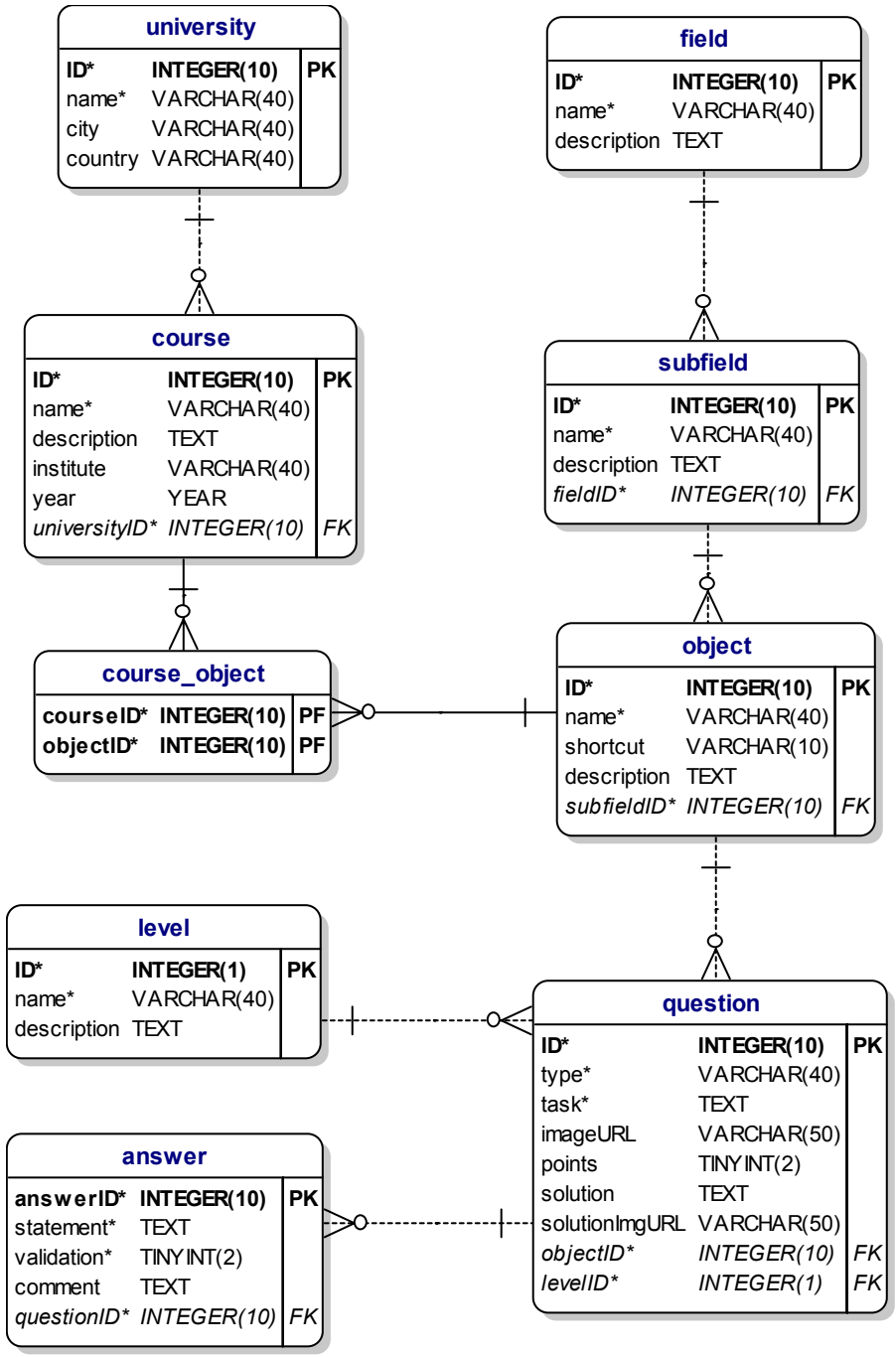

Figure 6: Simplified database diagram (ER related)

6.4 Application program

The development release of the application program is stored on the private web server of one of the project team members [devel]. The web application as well as the SQL files for generating the database and all milestone-documents of this project will be handed on to the client on April 22nd 2005, at the final presentation of the project.

6.4.1 Functionality

It was not the aim of this project to deliver a fully functional application program for the Management and Administration of the designed database. Some of the most important functionalities have been implemented, yet to make the system really usable, other functionalities need to be implemented later on. For a list of functionalities, which should at least be implemented to make the administration of the database easily useable, please refer to the appendix (section 9.5).

The delivered web application allows the user to

- Select area of self-assessment by specifying university courses
- Select area of self-assessment by specifying subfields
- Select area of self-assessment by specifying learning objects
- Specify difficulty of questions by selecting the question level.
- Specify maximum number of questions for a quiz.
- Do self-assessment quiz by answering multiple choice questions.
- Review done quiz, viewing the incorrectly answered questions inclusive their right answers and solution.
- Redo incorrectly answered questions.
- Add new learning object to the database by specifying all important information.
- Add new question to the database, including answers to the question.
- View content of the database, seeing names of all fields and subfields and being able to browse through all learning objects.

Out of these use cases, three main functionalities can be considered as implemented:

- Doing self-assessment in the form of a multiple choice quiz.
- Adding new learning object to the database.
- Adding new question (inclusive answers) to the database.

The additional functionality of browsing through the content of the database is implemented partly (browsing through all objects). The functionalities have been implemented in a way, so that the risk for the user of making bigger mistakes is reduced.

6.4.2 Main use cases

In this section we explain and show, how the implemented functionalities of doing self-assessment, adding new learning objects and adding new questions are presented to the user and which steps the user has to perform to use these functionalities. Descriptions as well as the images used for illustration are based on the development release of the web application [devel].

Doing Self-Assessment

Steps to perform

1. Click button 'Tutor' on main page
2. Select the universities, courses and subfields, which cover the learning objects for the quiz and click 'Continue'.
3. Select learning object(s) for self assessment on the next page and click 'Continue'
4. Select the question level and the maximum number of questions for the quiz
5. Answer all questions by checking the correct answers and clicking button 'Next question'. If last answer of quiz is displayed, the submit button is named 'Quiz Results' instead.
6. View quiz result (own answers are shown for each wrongly answered question, correct answers are marked) and choose whether to redo the wrong questions or start a new quiz.

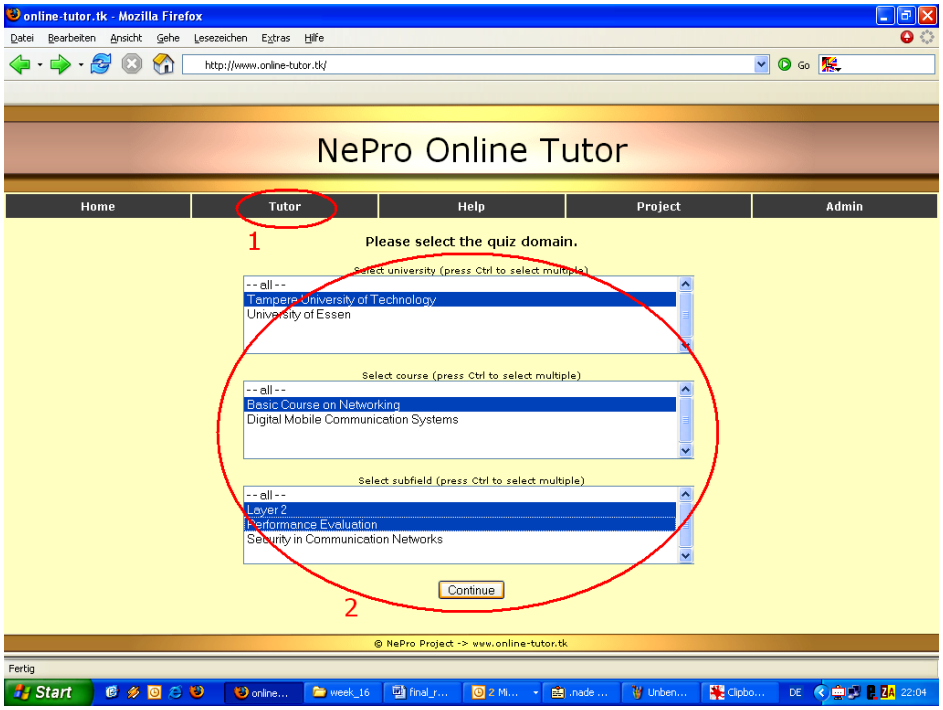

Figure 7: chooseQuiz.php

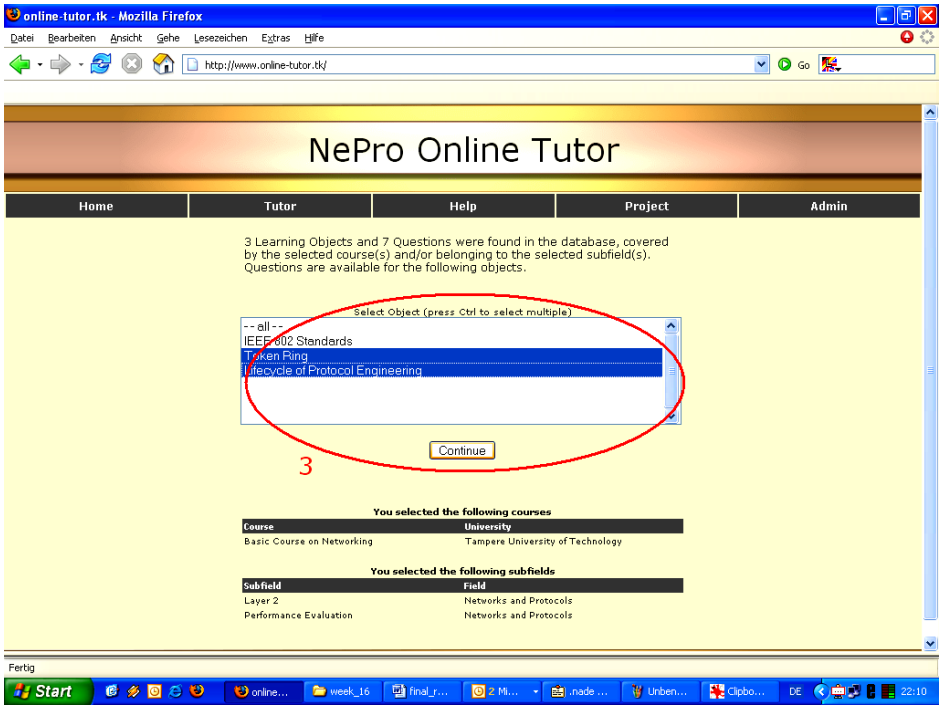

Figure 8: prepareQuiz.php

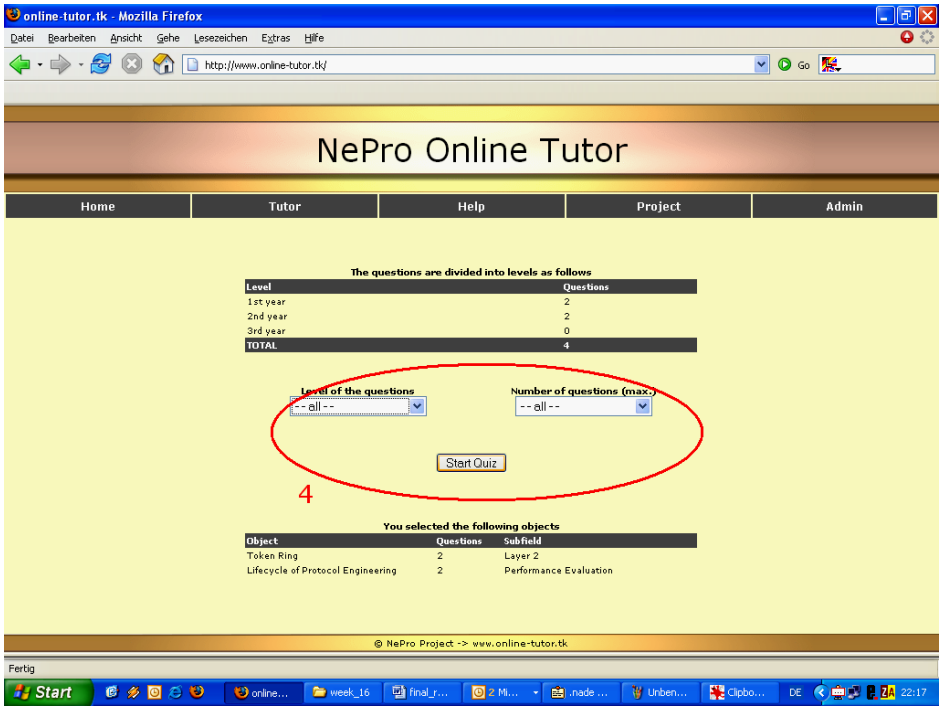

Figure 9: startQuiz.php

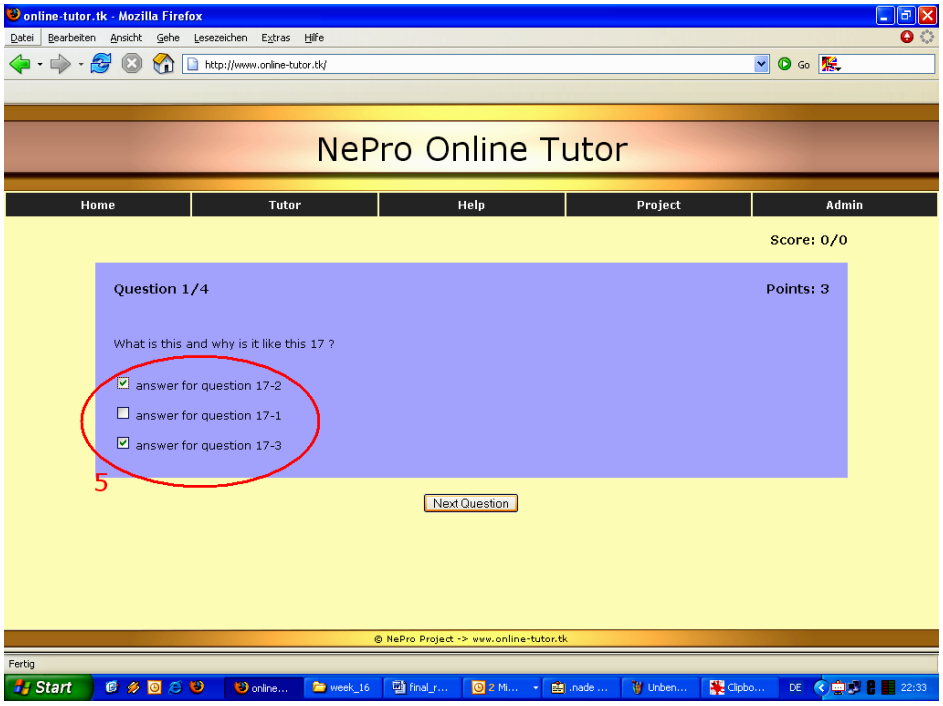

Figure 10: quiz.php - Answering

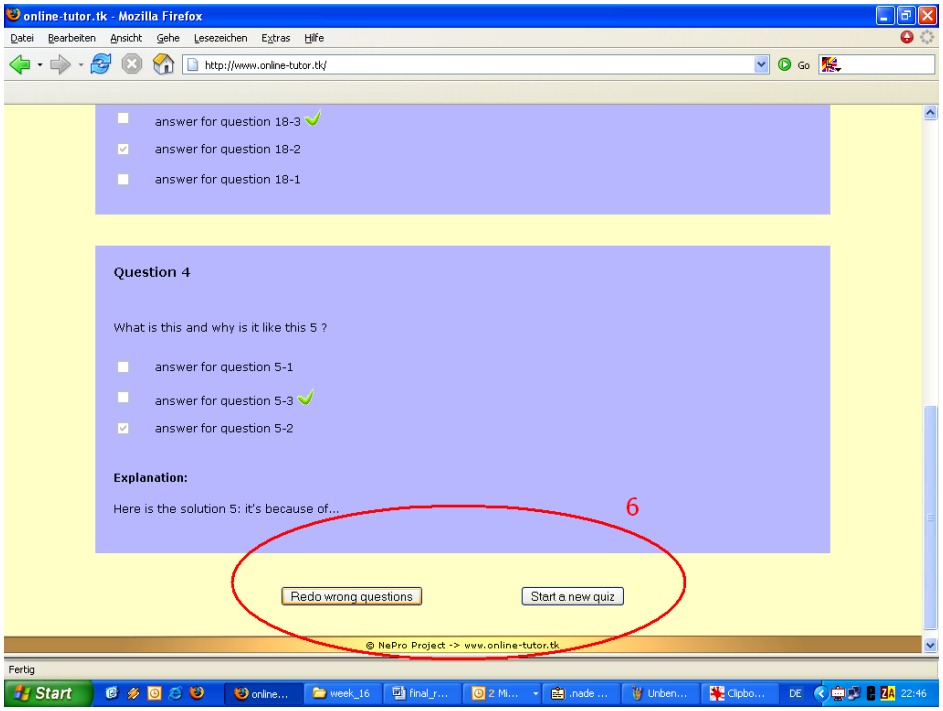

Figure 11: quiz.php - Feedback

Adding new Learning Object

Steps to perform

1. Click button 'Admin' on main page to get to the administrative view.
2. Click button 'Add Object' to get to the form for adding a new object.
3. Specify at least all necessary information, marked with asterisk (*). Obligatory Fields are name, subfield and courses.
4. Click 'Add new Learning Object' to add the object.

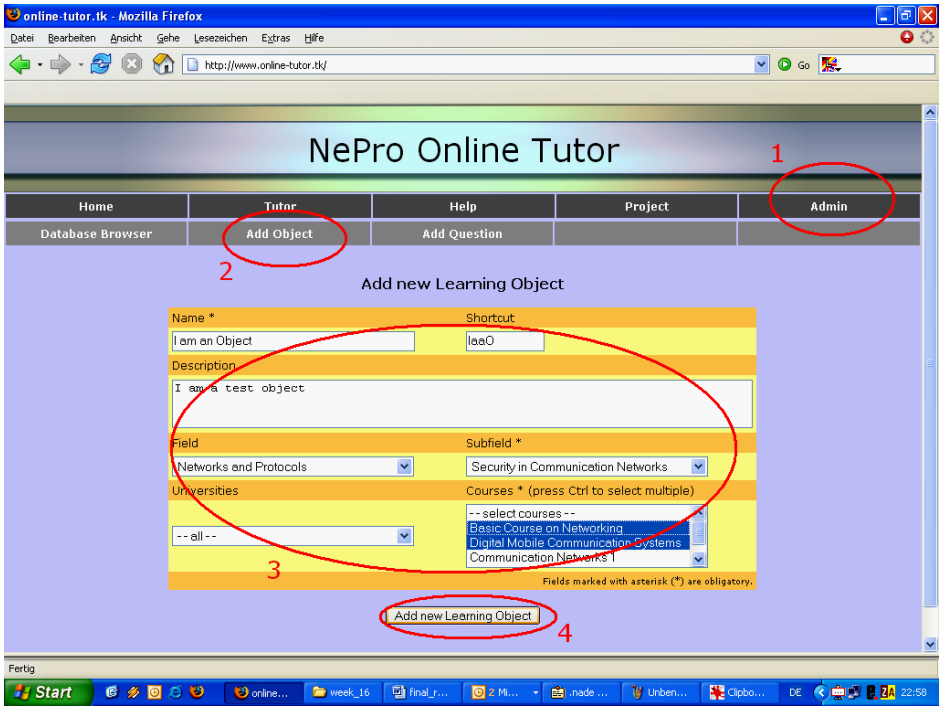

Figure 12: adminObjects.php

Adding new Question

Steps to perform

1. Click button 'Admin' on main page to get to the administrative view.
2. Click button 'Add Question' to get to the form for adding a new question.
3. Specify at least all necessary information, marked with asterisk (*). Obligatory Fields are
4. Click 'Add new Question' to add the question.

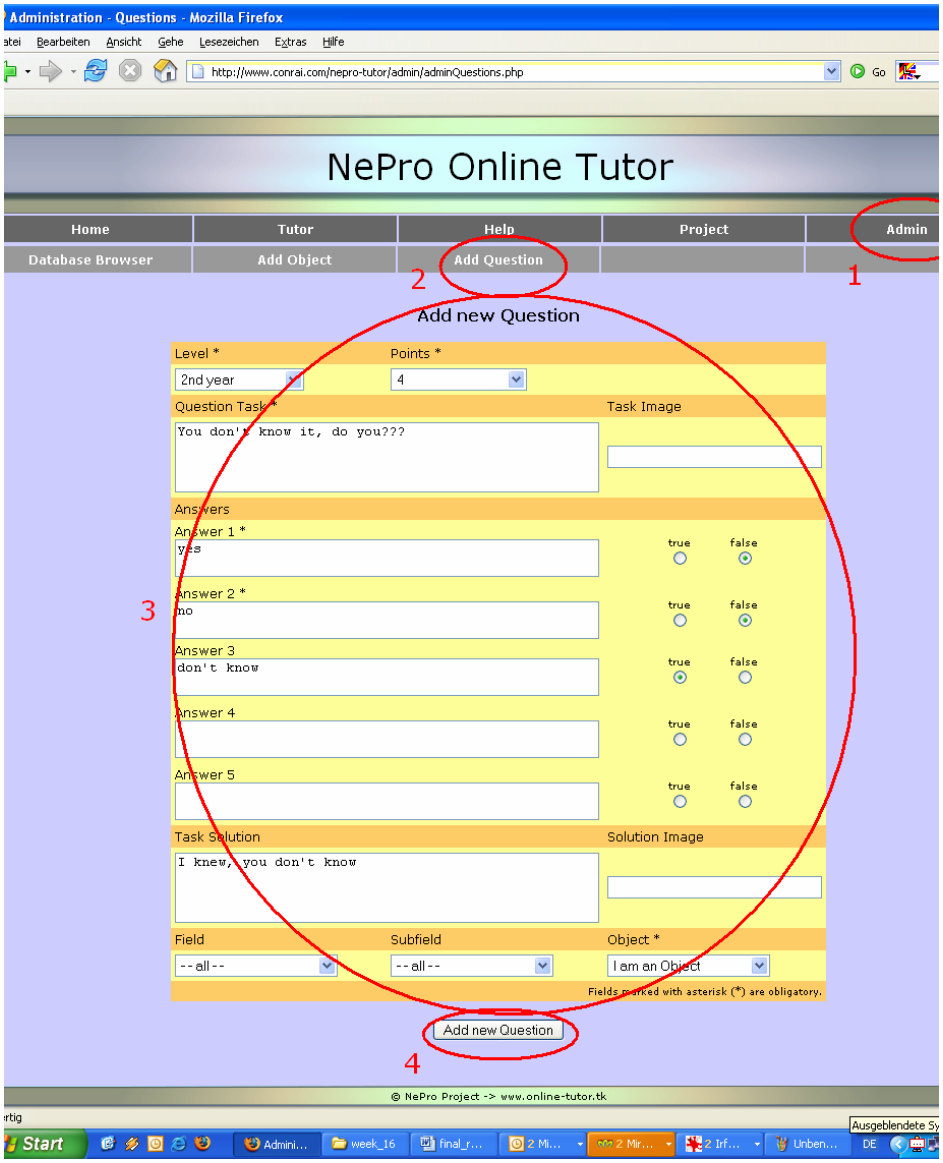

Figure 13: adminQuestions.php

6.4.3 Architecture

Figure 14 shows the basic architecture of the web application.

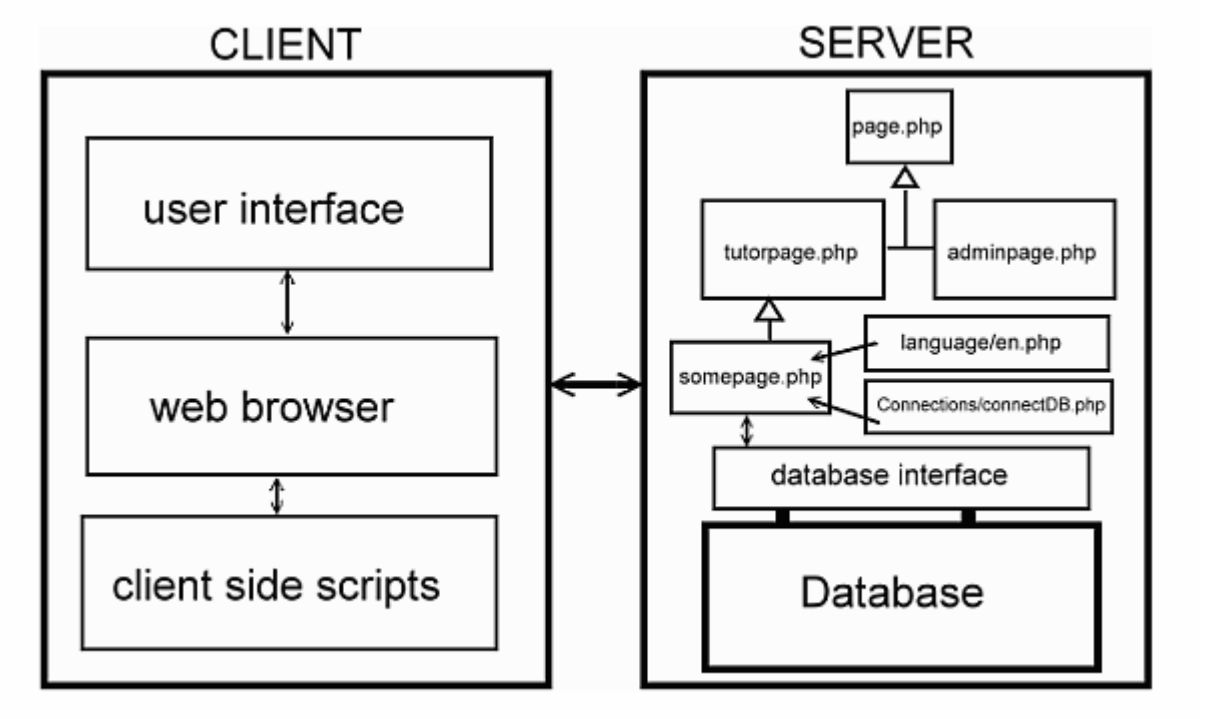

Figure 14: Architecture of web application

On the server side, a PHP page 'somepage.php' is extended either from 'tutorpage.php' or 'adminpage.php' (in this case from 'tutorpage.php', there are additional buttons on the pages extended from 'adminpage.php'), which in return are extended from page.php. This inheritance eases the consistent layout for all pages. 'somepage.php' includes 'language/en.php' in order to display the correct language as well as 'Connections/connectDB.php' which is responsible for connecting to the database interface.

On the client side the site 'somepage.php' is shown, using a web browser and displayed correctly with the help of client side scripts (JScript).

Figure 15 shows the folder structure of the web application.

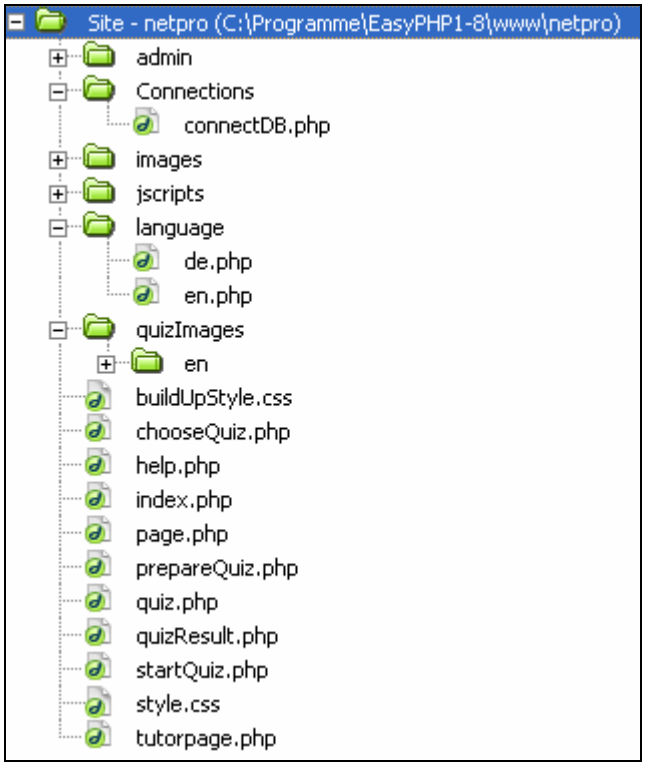

Figure 15: Folder structure of web application

Explanation:

- Folder 'Connections' consists of the class 'connectDB.php' which is responsible for setting up the connection to the MySQL database.
- Folder 'images' contains the images for the general layout of the pages
- Folder 'jscripts' contains the Java Script (JScript) files necessary for correct functionality of the web application
- Folder 'language' contains the language resource files (one file for each language), which contain the strings printed on the screen for the respective language.
- Folder 'quizImages' contains the images which are assigned to and shown with a question when doing a quiz (self-assessment).
- The PHP files necessary for generating and displaying a site are currently in main directory (here: C:\Programme\EasyPHP1-8\www\netpro) or in the admin directory (for administrative functions, this folder is password protected on the development server [devel]

The php files are commented to make them understandable more easily and ease the continuation of development in the scope of future projects.

7 Conclusion

At the end of the project the project team arrives at the conclusion that not everything went without difficulties. The division of the work had to be changed because of the time constraints and the different knowledge of each team member in different fields. The team found out that comparing content of curricula, objects, and questions is not that easy, especially if the knowledge of the participants is different and limited, the terms are used in a different way and also much course material was not in English language; and this was the only language all team members were able to understand. Translation of technical terms was sometimes also a challenge. In fact it was a helpful experience for the participants for the future. Another difficulty was that not every time and from every direction the team members got the support and feedback they hoped for.

But the challenge was to continue the project as good as possible with the best possible results. We had to skip some work and could not finish it as we planned it before. Important for the team was that at the end there were a usable result for a continuing project. The team members are sure that the outcome is a good basis for further projects. Refining the object catalogue is still possible and there will never be a perfect structure. Finding and allocating questions can be continued and the application system is also ready for extensions and improvements. Especially the database is well designed and structured for using in further projects; it is normalized, ready for multi-lingual use and provides all the information needed for the purpose of this special self-assessment situation.

It is also a good basis for integrating the database in a wider framework or other existing system. Interfaces are needed to be developed and standards have to be taken into consideration. But already now the implemented application provides a good opportunity to start with the self-assessment. It is already more suitable for this purpose than applications that are built for common use.

The software system can be installed at common server systems and the database can be set up. The project team hopes that their work will be continued in a later project because there are still lots of things to do and there are persons who are interested in using this system.

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9 Appendix

9.1 Courses Overview

Course Name	Translation	Abbreviation	University
Communications Engineering	Communications Engineering	CE	JKU
Digitaalinen Siirtotekniikka	Digital Transmission	DT	TUT
Digitaaliset Matkaviestimet	Digital Mobile Communication Systems	DMCS	TUT
Hochgeschwindigkeitsnetze	High-Speed Networks	HGN	Essen
Kommunikationsnetze 1	Communication Networks 1	KN1	Essen
Kommunikationsnetze 2	Communication Networks 2	KN2	Essen
Laajakaistaverkkojen Jatkokurssi	Advanced Topics in Broadband Networks	ATBN	TUT
Laajakaistaverkot	Broadband Networks	BN	TUT
Mobile Netze	Mobile Networks	MN	Essen
Netzmanagement	Network Management	NM	Essen
Sicherheit in Kommunikationsnetzen	Security in Com. Networks	SIKN	Essen
Tietoliikenneprotokollat	Communication Protocols	CP	TUT
Tietoliikennetekniikan Perusteet	Introduction to Telecommunications	ITT	TUT
Tietoliikenneteoria	Communication Theory	CT	TUT
Tietoliikenneprotokollien jatkokurssi	Advanced Topics in Communication Protocols	ATCP	TUT
Tietoliikenneverkkojen Perusteet	Basic Course on Networking	BCN	TUT
Traffic Engineering	Traffic Engineering	TRE	JKU
Verkkotekniikan Jatkokurssi	Advanced Course on Networking	ACN	TUT
Verkon Tietoturva	Security for Networks	SN	TUT
Wireless LANs	Wireless LANs	WL	TUT

9.2 Catalogue of Learning Objects

9.2.1 General

Object Number	Object	Associated Courses
1.	Addressing Concepts	KN1
2.	Amplitude Modulation	DT
3.	Bandwidth	BCN
4.	Basics of Protocols	ITT
5.	Broadcasting	BCN
6.	Browsers	BCN
7.	Cables	ITT
8.	Frequency Modulation	DT
9.	HUBs	BCN
10.	Internet Service Provider	BCN
11.	LAN	BCN
12.	MAN	BCN
13.	Modems	ITT
14.	Network Nodes	CT
15.	Network Topologies	KN1
16.	Other Connection Properties	KN1
17.	Relaying Principles	KN1
18.	Routers	BCN
19.	Streams	BCN
20.	Switches	BCN
21.	Terminal adapters	BCN
22.	Trends, Services and Req. of Com. Networks	KN1
23.	WAN	BCN

9.2.2 GSM/UMTS/3G

Object Number	Object	Associated Courses
24.	Authentication Centre	DMSC
25.	Base Station Subsystem	DMSC
26.	Base Transceiver Station	DMSC
27.	Basic Architecture	BCN
28.	Channels and Codes	DMSC
29.	Code Division Multiple Access	DMSC
30.	GPRS	DMSC
31.	GPRS Support Node	DMSC
32.	Mobile Communication – Fundamentals	DMSC
33.	Mobile Service switching Control	DMSC
34.	Mobile Station	DMSC
35.	Multicarrier Modulation	CT
36.	Multiple Access	DMSC
37.	Network management	BCN
38.	Network subsystem	DMSC
39.	Operation Subsystem	DMSC
40.	Other Services and Applications	DMSC
41.	Radio Interface	DMSC
42.	Short Message Service	DMSC
43.	Speech Coding and Modulation	CT
44.	Wireless Application Protocol	WL
45.	Visitor Location Register	DMSC

9.2.3 ISDN / ATM

Object Number	Object	Associated Courses
46.	ATM Basic Concept	HGN
47.	ATM Reference Model	HGN
48.	B-Channel	ITT
49.	Channels, Interfaces, Reference Points	KN2
50.	D-Channel	KN2 & ITT
51.	D-Channel Layer 2	KN2
52.	D-Channel Layer 3	KN2
53.	Hierarchical Structure	HGN
54.	Interfaces and Reference Points	HGN
55.	ISDN Basic Concept	KN2
56.	ISDN Reference Model ITU-T	KN2
57.	Layer and Adaptation Layer	HGN
58.	Physical and Virtual Connections	HGN
59.	SS7 – Overview	KN2
60.	SS7 Message Transfer Part	KN2
61.	SS7 Protocol Architecture	KN2
62.	Subscriber Signalling – Overview	KN2
63.	Traffic Control	HGN
64.	Virtual Paths and Channels	HGN

9.2.4 Layer 2

Object Number	Object	Associated Courses
65.	Address Resolution Protocol	KN1
66.	Addressing – Example LAPD	KN1
67.	Assured/Unassured Transmission	KN1
68.	Bridges	BCN
69.	Bridging	KN1
70.	Distributed Queue Dual Bus	KN2
71.	Error Detection – Example LAPD	KN1
72.	Ethernet 802.3	KN1
73.	Ethernet Topology	BCN
74.	Flow Control	KN1
75.	Functionality Layer 2	KN1
76.	IEEE 802 Standards	KN1
77.	MAC Protocols	KN1
78.	Point-to-Point Protocol	BCN
79.	Proxy	CAN
80.	Sequence Protection	KN1
81.	Token Passing	KN2
82.	Token Ring	KN2
83.	Tunnelling Protocol	BN
84.	V-LAN	KN1

9.2.5 Open System Interconnection

Object Number	Object	Associated Courses
85.	7-Layer Model	KN1
86.	Application Layer	BCN & KN1
87.	Data Link Layer	BCN & KN1
88.	Inter-Layer Communication	KN1
89.	Network Layer	BCN & KN1
90.	Physical Layer	BCN & KN1
91.	Presentation Layer	BCN & KN1
92.	Protocols and their Layers	KN1
93.	Session Layer	BCN & KN1
94.	Transport Layer	BCN & KN1

9.2.6 Other Mobile Systems

Object Number	Object	Associated Courses
95.	WLAN - Access points	WL
96.	WLAN - AD-HOC	WL
97.	Basics of Wireless Local Area Network	WL
98.	Bluetooth	DMSC
99.	WLAN - Cells	WL

9.2.7 Performance Evaluation

Object Number	**Object**	**Associated Courses**
100.	Event-controlled Simulation	KN2
101.	Lifecycle of Protocol Engineering	KN2
102.	Mathematical Analysis	KN2

103.	Methods of Performance Evaluation	KN2
104.	Random Processes, Variables, and Their Properties	KN2
105.	Simulation – Example M/M/1 process	KN2
106.	Simulation Principles	KN2
107.	White Noise	CT
108.	Impulse Noise	CT

9.2.8 Quality of Service

Object Number	Object	Associated Courses
109.	Controlled Load and Guarantied QoS	HGN
110.	DiffServ	HGN
111.	IntServ	HGN
112.	Network Quality of Service – Properties	HGN
113.	Queuing Disciplines	HGN
114.	Real Time Transport Protocol	HGN
115.	RSVP	HGN
116.	Traffic Measurement of VBR Streams	HGN

9.2.9 Security in Communication Networks

Object Number	Object	Associated Courses
117.	Access Control / Authentication	SIKN
118.	Basics and Terms	SIKN
119.	Certificates	SIKN
120.	Certification Authority	ACN
121.	Classification of Attacks	SIKN

122.	Cookies	SN
123.	Demilitarized Zone	SN
124.	Denial of Service	SN
125.	Digital Signatures	SIKN
126.	Distributed Denial of Service	SN
127.	Encryption Keys	SN
128.	Encryption Principles	SIKN
129.	Filtering on different Layers	SIKN
130.	Firewall Structure	SN
131.	Hash Functions / Message Authentication Code	SIKN
132.	IDS/Honeypots	SIKN
133.	IP Security	SIKN
134.	Key Management	SIKN
135.	Open Gates	SN
136.	OSI Security Services and Security Mecha-nisms	SIKN
137.	Overview of Firewalls	SIKN
138.	Packet Filtering	SN
139.	Public Infrastructure	SIKN
140.	Recognizing Attacks	SIKN
141.	Secure Socket Layer/TLS	SIKN
142.	Simple parity check	SN
143.	SSH	SIKN
144.	Trusted Third Party	SN
145.	Virtual Private Network	BCN

9.2.10 TCP / IP

Object Number	Object	Associated Courses
146.	Application Service Provision	ACN
147.	Basics of IP Networks	KN1
148.	Border Gateway Protocol	ACN
149.	Common Gateway Interface	BCN
150.	Connection Establishment and Termination	KN1
151.	Connection Termination	CP & BCN
152.	DHCP	ACN
153.	Distance Vector Routing	KN1
154.	Domain Name Server	CP
155.	Error Correction	KN1
156.	File Transfer Protocol	CP
157.	Flow Control	KN1 & CP
158.	Functions of Routers	KN1
159.	Header	KN1
160.	HTTP	ITT
161.	Internet Message Access Protocol	BCN
162.	IPv4 Addressing	KN1
163.	IPv4 Datagram – Format and Functions	KN1
164.	IPv4 Subnetting	KN1
165.	IPv6 Addressing	KN1_3 & CP_3
166.	IPv6 Subnetting	KN1_3 & CP_3
167.	Link State Routing	KN1
168.	Network Address Translation	BCN
169.	Packet Structure	DT & ITT
170.	Packet Switching	CP
171.	Port Concept	KN1

172.	Principles of Routing	KN1
173.	Routed and Routing Protocols	KN1
174.	Routing Tables	KN1
175.	State Automaton	KN1 & CP
176.	TCP Protocol Family	KN1 & CP
177.	Telnet	CP
178.	Uniform Resource Locator	ATCP & CP
179.	Window Allocation	CP
180.	Voice over IP	ACN

9.2.11 Transmission Systems

Object Number	Object	Associated Courses
181.	Asymmetric Digital Subscriber Line	BN
182.	Basics	KN2
183.	Digital Audio Broadcasting	DT
184.	Frame Relay	KN2
185.	Last Mile-Transmission Systems	KN2
186.	Multimedia Messaging Service	DT
187.	Multiplexing	ITT
188.	PCM	KN2
189.	PDH	KN2
190.	Peer-to-Peer	BCN
191.	Quadratude Amplitude Modulation	CT
192.	SDH/Sonet	KN2
193.	Synchronous & Asynchronous Connection	BCN
194.	X.25	KN2

9.3 Catalogue of questions

Here are listed the generated questions which can be used by the system. The template for the questions is mentioned and explained previously in this document (see Allocation questions to the objects).

9.3.1 GENERAL

ID	0	
Field	General	
Object	Cables	
QUESTION	Which of the following is not a reason to use fiber-optic cables for point to point data transmission?	
Q-Image	-	
Solution	Point-to-point transmission from one device to another using metal wires are much simpler than using fiber optics because they don't require the use of transmitter and receiver	
S-Image	-	
Level	1	
Points	2	
A 1	Need to assure data security.	F
A 2	Avoidance of ground loops.	F
A 3	Data-transfer rates too low to use metal cables.	T
A 4	Elimination of spark hazards.	F
A 5		

ID	1	
Field	General	
Object	Cables	
QUESTION	Light is confined within the core of a simple optical fiber by	
Q-Image		
Solution	If light hits a boundary of a material of lower refractive index at a steep enough angle, it cannot get out and it's reflected back into the high index medium.	
S-Image	cables1.jpg	
Level	2	
Points	3	
A 1	refraction.	F
A 2	total internal reflection at the outer edge of the cladding.	T
A 3	total internal reflection at the core cladding boundary.	F
A 4	reflection from the fiber's plastic coating.	F
A 5		

ID	2	
Field	General	
Object	Network Topologies	
QUESTION	Which of the following statement about interconnection networks is true?	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	2	
A 1	The number of channels on a single fiber that can transmit data simultaneously refers to the *degree of simultaneity*.	F
A 2	*Degree* is the number of channels on a single fiber.	F
A 3	Point-to-point communication connections are called *switches*.	F
A 4	*Diameter* is the number of links in the largest path between any two nodes.	T
A 5		

ID	3
Field	General
Object	Network Topology
QUESTION	Which ones of the next attributes determine the cost of a link? (list is not exhaustive)
Q-Image	
Solution	
S-Image	
Level	1
Points	3

A 1	The data rate of the link.	T
A 2	Changes in market.	F
A 3	The length of the link.	T
A 4	The queuing delay (congestion) experienced by packets traversing the link.	T
A 5	Age of the link	F

ID	4
Field	General
Object	Other Connection Properties
QUESTION	Which of these statements is correct?
Q-Image	
Solution	
S-Image	
Level	1
Points	2

A 1	ATM is a connection oriented system and is implemented with circuit switching.	F
A 2	The OSI network model is the only correct model.	F
A 3	The internet has a connectionless network layer but it can run over ATM even though ATM has a connection oriented layer.	T
A 4	Different types of networks can be connected with the same hardware	F
A 5		

ID	5	
Field	General	
Object	Other Connection Properties	
QUESTION	The problem of bridging connectionless LANs with ATM can be solved by	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	3	
A 1	introducing a LAN Emulation Server.	T
A 2	a fully connected topology	F
A 3	virtual circuits	F
A 4	having repeaters to boost the signals.	F
A 5		

ID	6	
Field	General	
Object	Switches	
QUESTION	Which statement about *circuit switching* is false?	
Q-Image		
Solution	If the Internet needs to run over an ATM based subnet, then the host first establishes an ATM connection to the destination before sending independent (IP) packets over it.	
S-Image		
Level	1	
Points	3	
A 1	A connection-oriented system can be implemented with a circuit switching system	F
A 2	A physical connection between source and destination is established first.	F
A 3	Circuit switching is a form of store and forwarding. Each block of data is sent in its entirety before being retransmitted to the next router until it reaches its destination	T
A 4	Once communication begins, there will be no further interruptions	F
A 5		

ID	7	
Field	General	
Object	Routers	
QUESTION	Getting a packet from the source to destination through several connected networks is known as _____.	
Q-Image	-	
Solution	This is what routing means.	
S-Image	-	
Level	1	
Points	1	
A 1	Addressing	F
A 2	Switching	F
A 3	Routing	T
A 4	Broadcasting	F
A 5	Sub netting	F

ID	8	
Field	General	
Object	TCP State Automaton	
QUESTION	What will happen if a receiver confirms receipt of a message but the confirmation is lost before it reaches the sender?	
Q-Image	-	
Solution	Sender thinks that the receiver never got the message and sends it again.	
S-Image	-	
Level	3	
Points	3	
A 1	ACK	F
A 2	NAK	F
A 3	ready	F
A 4	resend	F
A 5	timeout	T

ID	9	
Field	General	
Object	Cables	
QUESTION	A parallel cable must be short because over a long distance the signals on the wires can become out of sync. This is known as _____.	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	3	
A 1	distortion	F
A 2	disorder	F
A 3	noise	F
A 4	skew	T
A 5		

ID	10	
Field	General	
Object	Modems	
QUESTION	A modem converts from _____ to _____ signals when sending data from a computer to an older telephone line.	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	2	
A 1	sin – cos	F
A 2	analog – digital	F
A 3	digital – analog	T
A 4	FM – AM	F
A 5	AM - FM	F

ID	11	
Field	General	
Object	Cables	
QUESTION	Which of the following would NOT generally improve data transmission on cables?	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	2	
A 1	Using shorter cables	F
A 2	Using shielding or insulation	F
A 3	Using a medium with low electrical resistance	F
A 4	Decreasing the number of cable twists per metre	T
A 5		

ID	12	
Field	General	
Object	Cables	
QUESTION	Which category of UTP cable can be used for both Ethernet and Fast Ethernet?	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	5	
A 1	Category 1	F
A 2	Category 2	F
A 3	Category 3	F
A 4	Category 4	F
A 5	Category 5	T

ID	13	
Field	General	
Object	LAN	
QUESTION	Which type of connector is most commonly used for LANs?	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	4	
A 1	D	F
A 2	BNC	F
A 3	RJ-11	F
A 4	RJ-45	T
A 5		

ID	14	
Field	General	
Object	Cables	
QUESTION	How many pairs of wires are in most UTP cables used today?	
Q-Image	-	
Solution	Four pairs is correct.	
S-Image	-	
Level	3	
Points	4	
A 1	1	F
A 2	2	F
A 3	3	F
A 4	4	T
A 5	5	F

ID	15	
Field	General	
Object	Trends, Services and Requ. of Com. Networks	
QUESTION	What is the most important difference between the Internet and an Intranet?	
Q-Image	-	
Solution	Internet doesn't have a fixed number of users.	
S-Image	-	
Level	2	
Points	3	
A 1	the geographical distances covered	F
A 2	the number of users who have access	T
A 3	the network protocols used	F
A 4	the network software used	F
A 5		

ID	16	
Field	General	
Object	Trends, Services and Requ. of Com. Networks	
QUESTION	Which workstation operating system has built-in network server capabilities?	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	2	
A 1	Windows for Workgroups 3.11	F
A 2	Windows NT Workstation	F
A 3	Windows 2000 Professional	F
A 4	Linux	T
A 5		

ID	17	
Field	General	
Object	Other Connection Properties	
QUESTION	The way that two different devices are connected is the	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	1	
A 1	interface	T
A 2	medium	F
A 3	protocol	F
A 4	topology	F
A 5	constant	F

ID	18	
Field	General	
Object	Bandwidth	
QUESTION	A signal transmitting at 2.5 MHz can encode 8 bits per cycle. What is the bandwidth of the signal?	
Q-Image	-	
Solution	8*2,5Mhz = 20Mbit / s	
S-Image	-	
Level	2	
Points	2	
A 1	1Mbit / s	F
A 2	5Mbit / s	F
A 3	20Mbit / s	T
A 4	100Mbit / s	F
A 5		

ID	19	
Field	General	
Object	Network Topologies	
QUESTION	Which type of network topology requires the least amount of cable?	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	2	
A 1	bus	T
A 2	mesh	F
A 3	ring	F
A 4	star	F
A 5	tree	F

ID	20	
Field	General	
Object	Addressing Concepts	
QUESTION	Which type of server lists many types of resources available on the network?	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	3	
A 1	file	F
A 2	directory	T
A 3	print	F
A 4	mail	F
A 5	archive	F

ID	21	
Field	General	
Object	Network Topologies	
QUESTION	Which is **NOT** generally a result of installing a network?	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	3	
A 1	increased peripheral cost	T
A 2	need for administrator	F
A 3	organizational changes	F
A 4	security holes to plug	F
A 5		

ID	22	
Field	General	
Object	LAN	
QUESTION	What type of device is used to lengthen a LAN size by strengthening the signal?	
Q-Image	-	
Solution	Repeater strengthens all passing signals.	
S-Image	-	
Level	2	
Points	3	
A 1	bridge	F
A 2	gateway	F
A 3	repeater	T
A 4	router	F
A 5	switch	F

ID	23	
Field	General	
Object	HUBs	
QUESTION	What type of device is used to easily expand the network?	
Q-Image	HUB2.jpg	
Solution		
S-Image	HUB1.jpg	
Level	1	
Points	2	
A 1	bridge	F
A 2	HUB	T
A 3	router	F
A 4	switch	F
A 5	gateway	F

ID	24	
Field	General	
Object	Internet Service Provider	
QUESTION	In order to make content available on the Internet you need to use a	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	2	
A 1	web browser	F
A 2	web client	F
A 3	web page	F
A 4	web server	T
A 5		

ID	25	
Field	General	
Object	Other Connection Properties	
QUESTION	Which of the following can **NOT** get you connected to the Internet?	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	1	
A 1	an Internet café	F
A 2	an Internet or online service provider	F
A 3	an isolated local area network	T
A 4	a standalone computer with a modem	F
A 5		

ID	26	
Field	General	
Object	Basics of Protocols	
QUESTION	A disadvantage of protocols is that they tend to limit	
Q-Image	-	
Solution	Protocols are a set of rules of DO's and DON'T's	
S-Image	-	
Level	1	
Points	2	
A 1	communication	F
A 2	innovation	T
A 3	interconnection	F
A 4	standardization	F
A 5		

ID	27
Field	General
Object	Amplitude Modulation
QUESTION	Which will most reduce the quality of analog data to be sent on a network?
Q-Image	-
Solution	
S-Image	-
Level	3
Points	3

A 1	many bits per sample	F
A 2	long sampling period	T
A 3	mpeg compression	F
A 4	non-linear digesting	F
A 5		

ID	28
Field	General
Object	Amplitude Modulation
QUESTION	Which type of modulation is likely to be most adversely affected by resistance during transmission over long distances?
Q-Image	-
Solution	
S-Image	-
Level	2
Points	2

A 1	phase	F
A 2	frequency	F
A 3	amplitude	T
A 4	quadrature	F
A 5		

ID	29
Field	General
Object	Modems
QUESTION	How are the RTS and CTS pins of a V.24 modem interface commonly used?
Q-Image	-
Solution	
S-Image	-
Level	3
Points	4

A 1	transmitting data	F
A 2	flow control	T
A 3	error checking	F
A 4	unused	F
A 5		

ID	30
Field	General
Object	Modems
QUESTION	Which indicator light on an external modem would tell you that your dial-up connection has succeeded?
Q-Image	-
Solution	CD = Carrier Detect
S-Image	-
Level	2
Points	3

A 1	DSR	F
A 2	Ground	F
A 3	CD	T
A 4	DTR	F
A 5		

ID	31
Field	General
Object	Bandwidth
QUESTION	Network N consist of two repeaters. They support a maximum bandwidth of 10Mbit/s. A switch S having 4 ports is operating with 100Mbit/s and full-duplex and is connecting the repeaters. What kind of topology does N have?
Q-Image	-
Solution	The switch creates a star topology while two repeaters that are connected to the switch do induce a bus on their sub-segment
S-Image	-
Level	2
Points	3

A 1	Star	T
A 2	Bus	T
A 3	Star/Bus	T
A 4	None of the above	F
A 5		

ID	32
Field	General
Object	Bandwidth
QUESTION	Network N consist of two repeaters. They support a maximum bandwidth of 10Mbit/s. A switch S having 4 ports is operating with 100Mbit/s and full-duplex and is connecting the repeaters. What is theoretical maximum bandwidth that can be realized?
Q-Image	-
Solution	In the sub-segments of the two repeaters there is each a maximum of 10Mbit/s possible. But as the switch provides 4 ports it is theoretically possible that two end-user systems connected to these ports and supporting full-duplex mode can use a bandwidth of 200Mbit/s, but only under each other.
S-Image	-
Level	2
Points	4

A 1	10Mbit/s	F
A 2	100Mbit/s	F
A 3	200Mbit/s	T
A 4	None of the given bandwidths can be reached	F
A 5		

ID	33	
Field	General	
Object	Lan	
QUESTION	Speeds of laboratory fiber optic Local Area Networks are now in the range of _____?	
Q-Image	-	
Solution	Optical fiber connected LANs which were tested were operating at 100 Mbits/s and up but have not exceeded far from this figure.	
S-Image	-	
Level	1	
Points	1	
A 1	1 Mbits/s.	F
A 2	10 Mbits/s.	F
A 3	gigabits per second.	F
A 4	hundreds of megabits per second.	T
A 5		

ID	34	
Field	General	
Object	Streams	
QUESTION	The letter A is represented the same in ASCII and EBCDIC except for the	
Q-Image		
Solution		
S-Image		
Level	3	
Points	3	
A 1	least significant bit	F
A 2	most significant bit	T
A 3	parity bit	F
A 4	start bit	F
A 5		

9.3.2 LAYER2

ID	35
Field	Layer 2
Object	IEEE 802 Standards
QUESTION	Which type of network was NOT originally standardized by the IEEE 802 committee because of speed?
Q-Image	-
Solution	
S-Image	-
Level	3
Points	4

A 1	wireless	F
A 2	token bus	F
A 3	token ring	F
A 4	MAN	F
A 5	FDDI	T

ID	36
Field	Layer 2
Object	IEEE 802 Standards
QUESTION	Network devices support one or more standards of the IEEE802.3. Which of the following combinations are possible?
Q-Image	-
Solution	There is no restriction on implementations except that they should be correct and work fine with devices of the same standards.
S-Image	-
Level	3
Points	4

A 1	Repeater with Ethernet, Fast Ethernet and Gigabit Ethernet	T
A 2	Switch with Ethernet, Fast Ethernet, but no Gigabit Ethernet	T
A 3	There are no restrictions on combinations as long as the standard is implemented correctly.	T
A 4	All possible combinations are listed in the manual of IEEE802.3. Other combinations are not possible due technical reasons.	F
A 5		

9.3.3 OSI

ID	37
Field	OSI
Object	Protocols and their Layers
QUESTION	Which type of error correction is most commonly used at the end of message packets in popular OSI model compliant network protocols?
Q-Image	-
Solution	
S-Image	-
Level	3
Points	4

A 1	vertical redundancy check	F
A 2	longitudinal redundancy check	F
A 3	cyclical redundancy check	T
A 4	checksum	F
A 5		

ID	38
Field	OSI
Object	Protocols and their Layers
QUESTION	Which is NOT a reason why forward error correction is rarely used in data communication and networking?
Q-Image	-
Solution	
S-Image	-
Level	3
Points	3

A 1	Few forward error correction algorithms have been invented	T
A 2	Sending the data to reconstruct the message would be a large overhead	F
A 3	The amount of processing required to reconstruct the message would be large	F
A 4	The error correction data could itself be damaged	F
A 5	It is faster and easier to just resend the data	F

9.3.4 PERFORMANCE EVALUATION

ID	39	
Field	Performance Evaluation	
Object	Impulse Noise	
QUESTION	Which type of noise is likely to be a problem on a LAN with thick co-axial cable and properly functioning terminators?	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	3	
A 1	impulse noise	T
A 2	cross-talk	F
A 3	echo	F
A 4	white-noise	F
A 5		

ID	40	
Field	Performance Evaluation	
Object	White Noise	
QUESTION	What is white noise in networking?	
Q-Image		
Solution	White noise means that the process (signal) does not have any memory. What you get at time *n* does not have any inuence on (is uncorrelated with) what you get at any other instance *m 6= n*	
S-Image		
Level	3	
Points	4	
A 1	Noise that is caused by malfunction of hardware	F
A 2	Noise that has no effect	F
A 3	Noise caused by temperature	F
A 4	Noise that has spread equally to all frequencies	T
A 5		

ID	41	
Field	Performance Evaluation	
Object	Mathematical Analysis	
QUESTION	What percent overhead would be used to perform both vertical and longitudinal redundancy checks on just two bytes of data?	
Q-Image	-	
Solution	(8 bits + 2 bits) / (8 bits + 2 bits + 16 bits) = 10/26 = 38.5%)	
S-Image	-	
Level	3	
Points	5	
A 1	12,5%	F
A 2	20%	F
A 3	38,5%	T
A 4	56,2%	F
A 5	89,9%	F

9.3.5 QUALITY OF SERVICE

ID	42	
Field	Quality of Service	
Object	Real Time Transport Protocol	
QUESTION	RTP provides end-to-end network transport functions suitable for applications transmitting _____ data.	
Q-Image	-	
Solution	RTP = Real Time Protocol	
S-Image	-	
Level	2	
Points	2	
A 1	scattered	F
A 2	real-time	T
A 3	fragmented	F
A 4	secured	F
A 5	connection	F

ID	43	
Field	Quality of Service	
Object	Network Quality of Service – Properties	
QUESTION	Which is NOT a general characteristic of connectionless protocols?	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	3	
A 1	Used for high data rates	F
A 2	High error rates are common	T
A 3	Performed at lower OSI levels	F
A 4	Used in LANs	F
A 5		

9.3.6 SECURITY IN COMMUNICATION NETWORKS

ID	44	
Field	Security in Communication Networks	
Object	Simple parity check	
QUESTION	Simple parity checking can NOT detect	
Q-Image		
Solution	Simple parity check counts the number of bits. If there has been an even number of errors, it can't find them because there's also even number of correct bits.	
S-Image		
Level	2	
Points	3	
A 1	an odd number of errors.	F
A 2	an even number of errors.	T
A 3	more than one error	F
A 4	less than four errors	F
A 5	any errors	F

ID	45	
Field	Security in Communication Networks	
Object	Simple parity check	
QUESTION	Simple parity checking can NOT detect	
Q-Image		
Solution	Simple parity check counts the number of bits. If there has been an even number of errors, it can't find them because there's also even number of correct bits.	
S-Image		
Level	2	
Points	3	
A 1	an odd number of errors.	F
A 2	an even number of errors.	T
A 3	more than one error	F
A 4	less than four errors	F
A 5	any errors	F

ID	46	
Field	Security in Communication Networks	
Object	Open Gates	
QUESTION	Which of these peripherals is NOT generally shared on the network?	
Q-Image	-	
Solution		
S-Image	-	
Level	1	
Points	1	
A 1	Printer	F
A 2	Modem	F
A 3	Monitor	T
A 4	Hard Disk	F
A 5		

ID	47	
Field	Security in Communication Networks	
Object	SSH	
QUESTION	What is a SSH?	
Q-Image	-	
Solution	SSH is a secure telnet which encrypts everything you type in and then unencrypts it on the server so your commands and passwords are all secret	
S-Image	-	
Level	1	
Points	3	
A 1	a program that encrypts all commands you type	T
A 2	Browser	F
A 3	a secure form of Telnet	T
A 4	Programming code	F
A 5		

ID	48
Field	Security in Communication Networks
Object	Cookies
QUESTION	What can cookies do?
Q-Image	-
Solution	A cookie is a message, text strings, sent from a Web server to the user's computer that is stored on the user's hard disk
S-Image	-
Level	2
Points	3

A 1	Transmit viruses	F
A 2	Transmit the browsing history to different web servers	F
A 3	Improve browsing by allowing a server to recall any customized information the user has set	T
A 4	Send vital data of computer’s security to internet	F
A 5	Track users' visits	T

ID	49
Field	Security in Communication Networks
Object	Denial of Service
QUESTION	A DoS attack is when the attacker launches an attack from his or her own computer, this is done by sending packets of data to the remote computer, for each packet sent the target machine receives one, this is a very uncommon form of denial of service because the attack most of the time is very unsuccessful and at times can be easily traced. True / False?
Q-Image	-
Solution	DoS = Denial of Service
S-Image	-
Level	2
Points	1

A 1	True	T
A 2	False	F
A 3		
A 4		
A 5		

9.3.7 TCP / IP

ID	50	
Field	TCP / IP	
Object	Connection Termination	
QUESTION	Connection termination involves a _____ handshake	
Q-Image	-	
Solution	Three-way-handshake is used in connecting	
S-Image	-	
Level	1	
Points	2	
A 1	one-way	F
A 2	two-way	T
A 3	three-way	F
A 4	four-way	F
A 5		

ID	51	
Field	TCP / IP	
Object	Window Allocation	
QUESTION	An ACK number of 1,000 means _____.	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	2	
A 1	999 bytes have been successfully received	F
A 2	1,000 bytes have been successfully received	F
A 3	segment 999 has been received	T
A 4	segment 1,000 has been received	F
A 5		

ID	52	
Field	TCP / IP	
Object	HTTP	
QUESTION	HTTP is the key _____ used to transfer data across the Internet or Intranet	
Q-Image		
Solution	Without HTTP, the Internet and World Wide Web would not exist as we now know it	
S-Image		
Level	1	
Points	2	
A 1	program	F
A 2	application	F
A 3	protocol	T
A 4	interface	F
A 5		

ID	53	
Field	TCP / IP	
Object	Simple Mail Transfer Protocol	
QUESTION	SMTP stands for?	
Q-Image		
Solution	The standard e-mail protocol on the Internet and part of the TCP/IP protocol suite	
S-Image		
Level	1	
Points	2	
A 1	Simple Mail Transfer Protocol	T
A 2	Socket Modem Transfer Protocol	F
A 3	Simple Modulation Tracking Procedure	F
A 4	Sun Method Trace Protocol	F
A 5		

ID	54	
Field	TCP / IP	
Object	FTP	
QUESTION	"_____ provides a relatively simple method for organizations and individuals to transfer various forms of data between systems or locations."?	
Q-Image	-	
Solution	FTP = File Transfer Protocol	
S-Image	-	
Level	2	
Points	2	
A 1	IMAP	F
A 2	BGP	F
A 3	SMTP	F
A 4	FTP	T
A 5	DHCP	F

ID	55	
Field	TCP / IP	
Object	DHCP	
QUESTION	When a DHCP client is first switched on, by what kind of a cast does it send the packet on the network with a DHCP request?	
Q-Image		
Solution	DHCP server allocates an IP address to the PC, from one of the scopes (the pools of addresses) it has available.	
S-Image		
Level	2	
Points	3	
A 1	Multicast	F
A 2	Unicast	F
A 3	Broadcast	T
A 4		
A 5		

ID	56
Field	TCP / IP
Object	Telnet
QUESTION	What is Telnet?
Q-Image	-
Solution	You can then enter commands through the Telnet program and they will be executed as if you were entering them directly on the server console.
S-Image	-
Level	1
Points	2

A 1	a type of network topology	F
A 2	a browser	F
A 3	a terminal emulation program for TCP/IP networks	T
A 4	a connection method	F
A 5	a network adapter	F

ID	57
Field	TCP / IP
Object	Packet Switching
QUESTION	During normal IP packet forwarding by a router, which of the following packet fields are updated?
Q-Image	-
Solution	IP header TTL and checksum are the only packet fields that need to be changed when passing a router.
S-Image	-
Level	3
Points	5

A 1	IP header Source address	F
A 2	IP header TTL	T
A 3	Destination UDP port number	F
A 4	Destination UDP address	F
A 5	IP header checksum	T

ID	58	
Field	TCP / IP	
Object	TCP Window Allocation	
QUESTION	In the TCP protocol, the receiver advertises the current size of the receive window to the sender. The sender uses this information to control congestion on the network.	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	2	
A 1	True	F
A 2	False	T
A 3		
A 4		
A 5		

ID	59	
Field	TCP / IP	
Object	Link State Routing	
QUESTION	To improve the data-rate, you connect your computer using separate links to ten different service providers! To balance the traffic a service will randomly balance transmitted and received packets over all the links.	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	3	
A 1	Your computer only needs one IP address.	F
A 2	TCP performance is likely to decrease because retransmissions might be triggered even without packet loss.	T
A 3	Trace route packets to your computer would always come over the link associated with the smallest IP address.	F
A 4	It is impossible to increase the download speed of this computer for any application using the above setup.	F
A 5	Having multiple links would increase the risk of packet fragmentation. This is true even if all the links have the same MTU.	F

ID	60	
Field	TCP / IP	
Object	Carrier Sense Multiple Access with Collision Detection	
QUESTION	What does CSMA/CD stand for?	
Q-Image	-	
Solution	CSMA/CD is the protocol designed to provide fair access to the channel shared by stations on the Ethernet	
S-Image	-	
Level	1	
Points	1	
A 1	Cross Switching Modem Account (Compact Distribution)	F
A 2	Carrier Sense Multiple Access with Collision Detection	T
A 3	Connective Sequence of Multiple Arrays with Cross Distortion	F
A 4	None of the above	F
A 5		

ID	61	
Field	TCP / IP	
Object	TCP Protocol Family	
QUESTION	Which of the following types of protocol data may be carried by an Ethernet system?	
Q-Image	-	
Solution	The Ethernet is merely a transport system that carries packages of data between computers. The system doesn't care what is in the packages.	
S-Image	-	
Level	1	
Points	2	
A 1	TCP/IP only	F
A 2	AppleTalk only	F
A 3	TCP/IP & AppleTalk	F
A 4	TCP/IP & Novell & AppleTalk	T
A 5		

9.3.8 TRANSMISSION SYSTEMS

ID	62	
Field	Transmission Systems	
Object	Basics	
QUESTION	What is the difference between full-duplex and half-duplex transmission?	
Q-Image		
Solution	Answer 2 is correct.	
S-Image		
Level	1	
Points	1	
A 1	Full-duplex transmission can be used for Gigabit Ethernet but half-duplex transmission cannot	F
A 2	In full-duplex transmission, signals can travel in both directions on the same connection simultaneously, while in half-duplex transmission, signals cannot travel in opposite directions simultaneously.	T
A 3	Full-duplex transmission can be used between multiple workstations and a repeater.	F
A 4	None of the above.	F
A 5		

ID	63	
Field	Transmission Systems	
Object	Frame Relay	
QUESTION	Which of the following are fields of an Ethernet frame?	
Q-Image		
Solution	These are important fields of Ethernet frame.	
S-Image		
Level	1	
Points	3	
A 1	Data field only	F
A 2	Source Ethernet Address field only	F
A 3	Data field & Source Ethernet Address field	F
A 4	Data field & Frame Check Sequence field Source & Ethernet Address field	T
A 5		

ID	64	
Field	Transmission Systems	
Object	Synchronous & Asynchronous Connection	
QUESTION	Which is true about synchronous and asynchronous connections?	
Q-Image	-	
Solution		
S-Image	-	
Level	2	
Points	3	
A 1	Asynchronous transmissions are generally used for large amounts of data.	F
A 2	Asynchronous transmissions are often combined with a clock signal.	F
A 3	Synchronous transmissions require synchronization bits at the end.	T
A 4	Synchronous transmissions have a larger overhead than asynchronous transmissions.	F
A 5		

ID	65	
Field	Transmission Systems	
Object	Basics	
QUESTION	Which type of serial connection will generally have the highest performance?	
Q-Image	-	
Solution	With full-duplex the signal can move both ways simultaneously.	
S-Image	-	
Level	1	
Points	2	
A 1	simplex	F
A 2	half-duplex	F
A 3	full-duplex	T
A 4	multiplex	F
A 5	complex	F

ID	66	
Field	Transmission Systems	
Object	Multiplexing	
QUESTION	Which type of multiplexing uses a round robin scheme?	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	4	
A 1	Time division multiplexing	T
A 2	Frequency division multiplexing	F
A 3	Statistical multiplexing	F
A 4		
A 5		

ID	67	
Field	Transmission Systems	
Object	Peer-to-Peer	
QUESTION	Which is not an advantage of client-server networks over peer-to-peer networks?	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	3	
A 1	centralized administration	F
A 2	initial investment	T
A 3	performance	F
A 4	strong user-based security	F
A 5		

ID	68
Field	Transmission Systems
Object	Synchronous & Asynchronous Connection
QUESTION	The purpose of bit stuffing in HDLC synchronization is
Q-Image	-
Solution	
S-Image	-
Level	3
Points	3

A 1	to detect errors in the data	F
A 2	to distinguish the data from the start and end of the message	T
A 3	to make the message have the required length	F
A 4	to make start and stop flags composed of long strings of 1s or 0s	F
A 5		

ID	69
Field	Transmission Systems
Object	Multimedia Messaging systems
QUESTION	What does the MMS stand for?
Q-Image	
Solution	MMS (Multimedia Messaging Service) is a universally accepted standard that lets users of MMS supportive mobile phones send and receive messages with formatted text, graphics, photographs, audio and video clips.
S-Image	
Level	1
Points	1

A 1	Multimedia Messaging Site	F
A 2	Multimedia Modulation Service	F
A 3	Multimedia Messaging Service	T
A 4	Modern Messaging Style	F
A 5		

ID	70
Field	Transmission Systems
Object	Multimedia Messaging Systems
QUESTION	Video sequences, audio clips and high-quality images can be downloaded to the phone from _____ sites.
Q-Image	-
Solution	MMS messages can be sent either to another MMS-enabled mobile phone or to an e-mail address. Multimedia can be downloaded from WAP sites.
S-Image	-
Level	2
Points	2

A 1	WAP	T
A 2	MAP	F
A 3	HTTP	F
A 4	FTP	F
A 5		

ID	71
Field	Transmission Systems
Object	Quadratude Amplitude Modulation
QUESTION	QAM stands for…?
Q-Image	-
Solution	QAM is a method of encoding used by digital cable providers
S-Image	-
Level	2
Points	3

A 1	Quartz Appendix Map	F
A 2	Quarter Amplifier Mode	F
A 3	Quiet Answering Method	F
A 4	Quadratude Amplitude Modulation	T
A 5		

ID	72	
Field	Transmission Systems	
Object	Plesiochronous digital hierarchy	
QUESTION	Plesiochronous digital hierarchy (PDH) is … ?	
Q-Image	-	
Solution	Plesiochronous digital hierarchy (PDH) and synchronous digital hierarchy (SDH) are two standardized multiplexing hierarchies that are based on the TDM principle.	
S-Image	-	
Level	3	
Points	5	
A 1	octet-interleaved	F
A 2	bit-interleaved	T
A 3	decade-interleaved	F
A 4	none of the above	F
A 5		

ID	73	
Field	Transmission Systems	
Object	Synchronous & Asynchronous Connection	
QUESTION	The purpose of a preamble is	
Q-Image	-	
Solution		
S-Image	-	
Level	3	
Points	3	
A 1	to delimit the start of the data	F
A 2	to make the packet meet the minimum length requirement	F
A 3	to provide synchronization	T
A 4	to provide error checking	F
A 5		

9.3.9 GSM/UMTS/3G

ID	74	
Field	GSM/UMTS/3G	
Object	Principles of Cellular Mobile Communications Systems	
QUESTION	Which of the following devices can be seen as mobile wireless devices?	
Q-Image		
Solution	All the devices can be seen as both mobile & wireless (on today's market). MP3 players can be also wired, but Bluetooth technology refers to wireless systems.	
S-Image		
Level	1	
Points	3	
A 1	A GPS receiver.	T
A 2	A WCDMA handset.	T
A 3	A Bluetooth MP3 player.	T
A 4		
A 5		

ID	75	
Field	GSM/UMTS/3G	
Object	Principles of Cellular Mobile Communications Systems	
QUESTION	Which of the followings is(are) true?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	Wired communications usually allow for more mobility than wireless communications.	F
A 2	An analog signal cannot be transmitted over a wireless channel; it can be only transmitted over wired channels.	F
A 3	The main advantage of the wireless communications over the wired communications is that they do not suffer of fading and multipath propagation.	F
A 4		
A 5		

ID	76	
Field	GSM/UMTS/3G	
Object	Principles of Cellular Mobile Communications Systems	
QUESTION	Which one(s) of the following properties or methods can be used to increase the efficiency of a cellular system?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	Discontinuous transmission	T
A 2	Transmitter power control	T
A 3	Frequency hopping	T
A 4		
A 5		

ID	77	
Field	GSM/UMTS/3G	
Object	Principles of Cellular Mobile Communications Systems	
QUESTION	Which are the consequences of dividing the geographical areas into small cells?	
Q-Image		
Solution	Division into small cells – advantages: • Lower transmitter powers => less interference to other users of the same system; less interference to other systems & longer battery life; • Flexible coverage: small cells for densely populated areas and large cells for rural areas • The network becomes more complicated and more expensive	
S-Image		
Level	1	
Points	3	
A 1	The network cost increases.	T
A 2	The interference between users increases.	F
A 3	The mobile battery life can be increased.	T
A 4		
A 5		

ID	78	
Field	GSM/UMTS/3G	
Object	Mobile Radio Environment	
QUESTION	Which of the following statements are true?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	Frequency hopping in GSM is used to provide frequency diversity (e.g., to combat fading).	T
A 2	In frequency hopping, the carrier frequency of the modulated information signal is kept constant during the whole transmission period	F
A 3	Frequency hopping is used because the interference degrading the transmission quality is usually not equally distributed to all radio channels.	T
A 4		
A 5		

ID	79	
Field	GSM/UMTS/3G	
Object	Mobile Radio Environment	
QUESTION	Fading in mobile communication environments refers to	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	The non-linear frequency distortions introduced by the channel.	F
A 2	The fluctuation of the amplitude of a radio signal over a short period of time or travel.	T
A 3	The propagation of the radio signal with constant low amplitude.	F
A 4		
A 5		

ID	80	
Field	GSM/UMTS/3G	
Object	GSM Basic Architecture	
QUESTION	Choose the correct statement or statements. In GSM...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	MS=ME+SIM	T
A 2	BSS=BSC+BTS+TRAU	T
A 3	NSS=MSC+VHS+HLR+EIR	F
A 4		
A 5		

ID	81	
Field	GSM/UMTS/3G	
Object	GSM Basic Architecture	
QUESTION	The Interworking Functions (IWF) are located between	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	User Terminal and Base Transceiver Station	F
A 2	Base Transceiver Station and Mobile Switching Centre	F
A 3	Mobile Switching Centre and other networks	T
A 4		
A 5		

ID	82	
Field	GSM/UMTS/3G	
Object	GSM Authentication Centre	
QUESTION	The Authentication Center (AC) is	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	a database unit for the management of mobile subscribers operating outside the area of their Home Location Register (HLR).	F
A 2	a database maintaining identity-related security information of the subscriptions	T
A 3	a database for the management of the mobile equipments whose IMSI is on the grey list.	F
A 4		
A 5		

ID	83	
Field	GSM/UMTS/3G	
Object	GSM Short Message Service	
QUESTION	The Short Message Services (SMS) are delivered by using	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	Operation, Administration and Maintenance functions	F
A 2	Radio Resource Management functions	F
A 3	Mobility Management functions	F
A 4		
A 5		

ID	84	
Field	GSM/UMTS/3G	
Object	GSM Speech Coding and Modulation	
QUESTION	Which of the following statements is(are) true?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	RPE in GSM stands for Recursive Prediction Error and refers to an algorithm of allocating the frequencies in each GSM cell according to the minimum bit error rate.	F
A 2	The speech coding scheme used in GSM is the RPE-LTP (Regular Pulse Excitation- Long Term Prediction)	T
A 3	The Regular Pulse Excitation (RPE) is a method of interleaving data bits	F
A 4		
A 5		

ID	85	
Field	GSM/UMTS/3G	
Object	GSM Speech Coding and Modulation	
QUESTION	Which of the following operations are in the correct order when you think about the processes involved at the receiver site, when transforming the radio wave into speech signal?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	The de-interleaved signal is error corrected via forward error correction schemes, and then (in the next stage) it is de-ciphered.	F
A 2	After demodulation and burst decoding, the signal is de-ciphered, de-interleaved, and, then, decoded in order to correct the errors introduced by the channel.	T
A 3	After demodulation, burst decoding and channel decoding, the signal is de-interleaved in order to achieve better properties for the source decoding stage, and, then, it is deciphered.	F
A 4		
A 5		

ID	86	
Field	GSM/UMTS/3G	
Object	GSM Speech Coding and Modulation	
QUESTION	When BT=0.4 and unmodulated data rate is r=800 kbit/s, what is a bandwidth of a Gaussian filter used in the GMSK modulation?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	approximately 160 kHz.	F
A 2	approximately 81.24 kHz.	F
A 3	approximately 320 kHz	T
A 4		
A 5		

ID	87	
Field	GSM/UMTS/3G	
Object	GSM Speech Coding and Modulation	
QUESTION	GMSK modulated signal ...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	has constant phase over the whole transmitted burst containing user or signaling data.	F
A 2	has a much better spectral efficiency compared to QPSK modulation.	F
A 3	can be demodulated using a Viterbi method (i.e., a maximum likelihood technique which tries to reduce the intersymbol interference).	T
A 4		
A 5		

ID	88	
Field	GSM/UMTS/3G	
Object	GSM Speech Coding and Modulation	
QUESTION	The demodulator in GSM ...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	is estimating the most probable sequence of modulating data, given the received distorted channel.	T
A 2	has to cope with signal attenuation and multipath propagation.	T
A 3	never uses the training sequences existing in the middle of each GSM burst, in order to save bandwidth.	F
A 4		
A 5		

ID	89	
Field	GSM/UMTS/3G	
Object	GSM Radio Interface	
QUESTION	Which one(s) of the following sentences is(are) true? Voice Activity Detection (VAD) is…	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	used to differentiate between noisy speech and noise.	T
A 2	synonymous with speech coding	F
A 3	a method to introduce noise into the speech signal, such that the signal is transmitted over the mobile channel with a higher average power	F
A 4		
A 5		

ID	90
Field	GSM/UMTS/3G
Object	GSM Radio Interface
QUESTION	A characteristic of Rayleigh fading is that
Q-Image	
Solution	
S-Image	
Level	1
Points	3

A 1	the received fading signal consists of a sum of Laplacian distributed signals, caused by the interference from other users	F
A 2	the received signal is the multiplication of 2 or more reflected signals, all having the same time delay (so called flat Rayleigh fading)	F
A 3	the received fading signal consists of a sum of reflected, phase-shifted signals whose amplitude is Rayleigh distributed	T
A 4		
A 5		

ID	91
Field	GSM/UMTS/3G
Object	GSM Radio Interface
QUESTION	What are the differences between fast frequency hopping (FFH) and slow frequency hopping (SFH)?
Q-Image	
Solution	
S-Image	
Level	1
Points	3

A 1	Burst transmission frequency remains the same during the whole burst in FFH	F
A 2	Burst transmission frequency remains the same during the whole burst in SFH	T
A 3	In SFH, the transmission frequency is changed slower than the modulation rate	T
A 4		
A 5		

ID	92	
Field	GSM/UMTS/3G	
Object	GSM Radio Interface	
QUESTION	In GSM, the timing advance...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	is computed by the BTS and transmitted to MS continuously during the duration of the connection.	T
A 2	means that MS delays its emission relatively to its reception by a time interval compensating the to and from (MS<-->BTS) delay.	F
A 3	is needed to fit the received bursts correctly into the time slots without over-lapping each other.	T
A 4		
A 5		

ID	93	
Field	GSM/UMTS/3G	
Object	GSM Radio Interface	
QUESTION	If we consider a radio transmission at the symbol rate 64 kbits/s over a channel with the maximum Doppler spread (or Doppler frequency) F=20 Hz and the multipath de-lay spread D=2 us (us=microseconds), then… (Note: the coherence bandwidth of the channel is approximately equal to 1/D)	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	the channel is fast fading for this particular transmission	F
A 2	the channel is flat fading for this particular transmission	T
A 3	the channel is frequency selective for this particular transmission	F
A 4		
A 5		

ID	94	
Field	GSM/UMTS/3G	
Object	Radio Multiple Access	
QUESTION	The frequency reuse factor in GSM is	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	1	F
A 2	higher than 1	T
A 3	-1	F
A 4		
A 5		

ID	95	
Field	GSM/UMTS/3G	
Object	Radio Multiple Access	
QUESTION	Which of the following multiple access techniques was selected for the 3rd generation wireless systems (3G)?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	time division multiple access (TDMA)	F
A 2	frequency division multiple access (FDMA)	F
A 3	code division multiple access (CDMA)	T
A 4		
A 5		

ID	96	
Field	GSM/UMTS/3G	
Object	Radio Multiple Access	
QUESTION	Which multiple access technique(s) is(are) used in GSM?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	Space Division Multiple Access (SDMA)	F
A 2	A combination of CDMA and FDMA	F
A 3	A combination of FDMA and TDMA	T
A 4		
A 5		

ID	97	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	Which of the following channel(s) is(are) not used to transfer speech in GSM?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	TCH/F	F
A 2	TCH/8	T
A 3	TCH/H	F
A 4		
A 5		

ID	98	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	Which of the following channel(s) is(are) used for synchronization purposes in GSM?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	RACH	F
A 2	PCH	F
A 3	FCCH	T
A 4		
A 5		

ID	99	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	Which channels are used in downlink direction in GSM?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	BCCH	T
A 2	RACH	F
A 3	AGCH	T
A 4		
A 5		

ID	100	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	The parity codes used in GSM...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	are non-linear block codes.	F
A 2	are able only to correct errors, but they are not able to detect them.	F
A 3	are used for RACH and SCH channels for error detection.	T
A 4		
A 5		

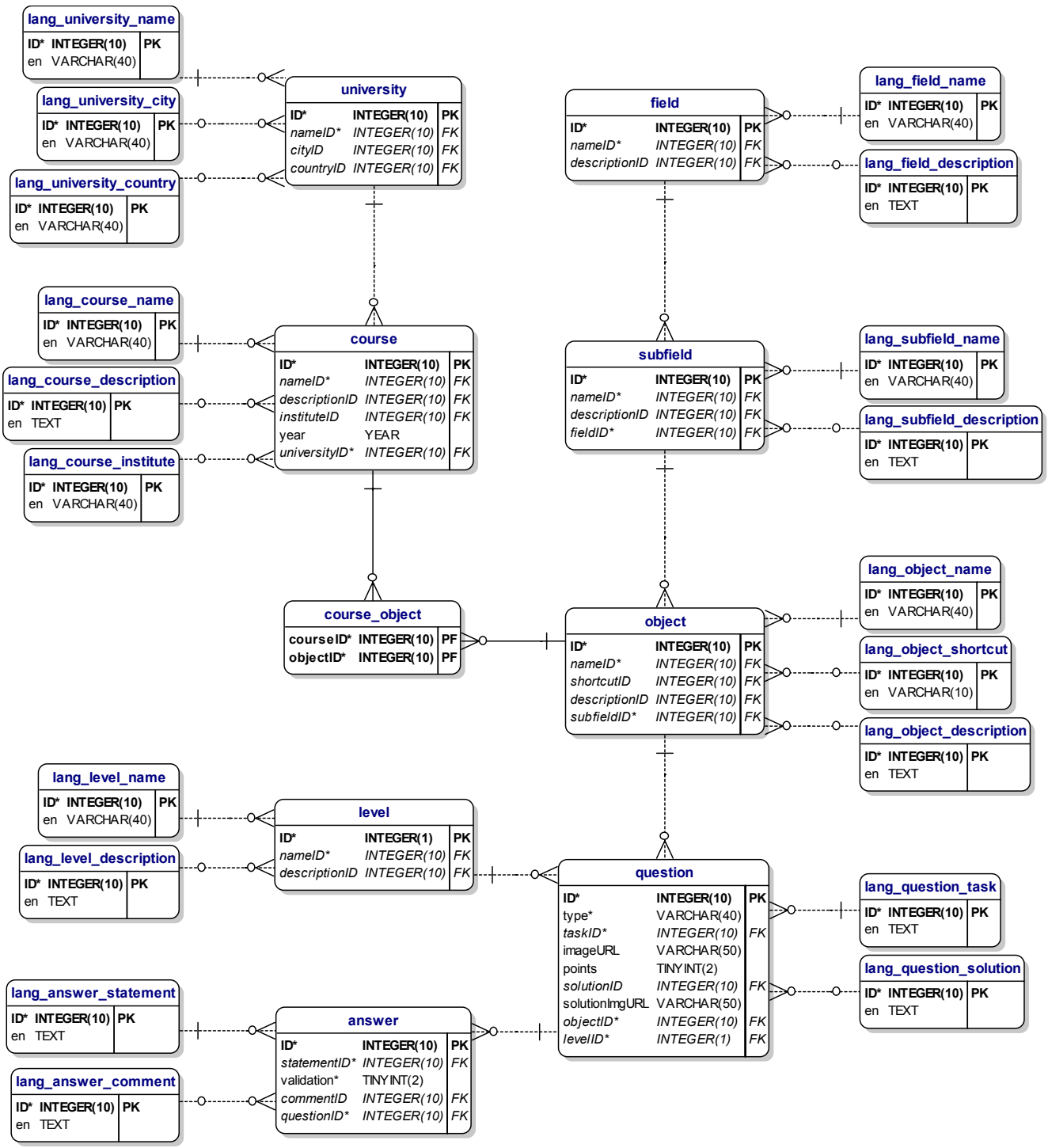
ID	101	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	The Fire code used in GSM is ...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	a convolutional code of rate 1/3 and constraint length of 7.	F
A 2	used to correct burst errors appearing on the fast associated signaling on TCH/F channels.	T
A 3	able to detect and correct burst errors (i.e., errors appearing in bursts).	T
A 4		
A 5		

ID	102	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	Puncturing a convolutional code means that...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	certain coded bits are transmitted twice or three times.	F
A 2	a higher rate code can be constructed by an original low rate code, by periodically refraining from the transmission of some code symbols..	T
A 3	for instance, a rate R=2/3 code can be derived from a rate R=1/2 "mother" code.	T
A 4		
A 5		

ID	103	
Field	GSM/UMTS/3G	
Object	Channels and Codes	
QUESTION	In GSM, the "Stealing flags" are used ...	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	to inform a de-interleaver which bursts have to be de-interleaved	F
A 2	to inform a decoder whether a data block contains user data or signaling.	T
A 3	to inform a decoder that an even number of bits was transmitted.	F
A 4		
A 5		

ID	104	
Field	GSM/UMTS/3G	
Object	GSM Base Station Subsystem	
QUESTION	When TRAU is physically distant from BTS, auxiliary information is needed to be sent from BTS to TRAU. Which ones of the following information bits are transmitted as auxiliary bits?	
Q-Image		
Solution		
S-Image		
Level	1	
Points	3	
A 1	Time alignment bits	T
A 2	Frame synchronization bits	T
A 3	Speech/Data and Full/Half Rate Discrimination bits	T
A 4		
A 5		

9.4 Database Diagram



9.5 Functionalities to be implemented

9.5.1 Administrative Functionalities to be implemented

Currently the web application allows the user to

- add learning objects and
- add questions (+ answers)
- view any objects stored to the database

to the database. In order to really be useable, at least the following functionalities should be implemented:

- add field
- add subfield
- add university
- add course

- browse through / view all stored fields
- view all stored subfields
- view all stored universities
- view all stored courses
- view all stored questions (incl. answers)

- edit field
- edit subfield
- edit university
- edit course
- edit object
- edit question (incl. answers)

- remove field
- remove subfield
- remove university
- remove course
- remove object
- remove question (incl. answers)

All the editing and removing functionalities for the elements (fields, subfields, objects etc.) could for example be available in the element browsers. I.e. when browsing to an object (as it is already possible now) it should be possible from there to edit or delete the object. Same can be realized for fields, subfields etc.

9.5.2 Other Functionalities to be implemented

For security reasons, following functionalities need to be implemented for the system, if it is really going to be used:

- User sessions
- User authorization

Furthermore the following functionalities would make the system more powerful:

- Logging user sessions
- User quiz tracking (results of quiz)
- Functionality for adding new language to the database language tables.
- Localizability