

The **i**Lab Experience

a blended learning hands-on course concept



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<http://pahl.de/>

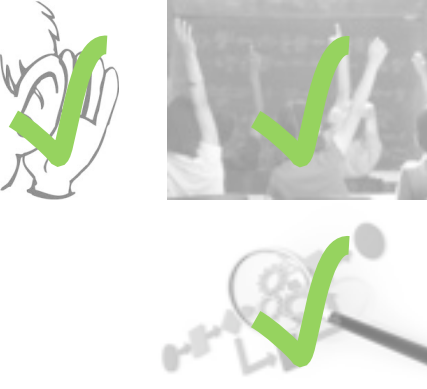


facts



- iLab (=Internet) & iLab² (=selected network architectures and services)
- Bachelor and Master Level hands-on lab
- 1 semester / 10 ECTS (~300h)
- over 1000 participants so far
- over 80 registrations for next semester

only possible as working with the eLearning platform scales



in short



listen



encourage

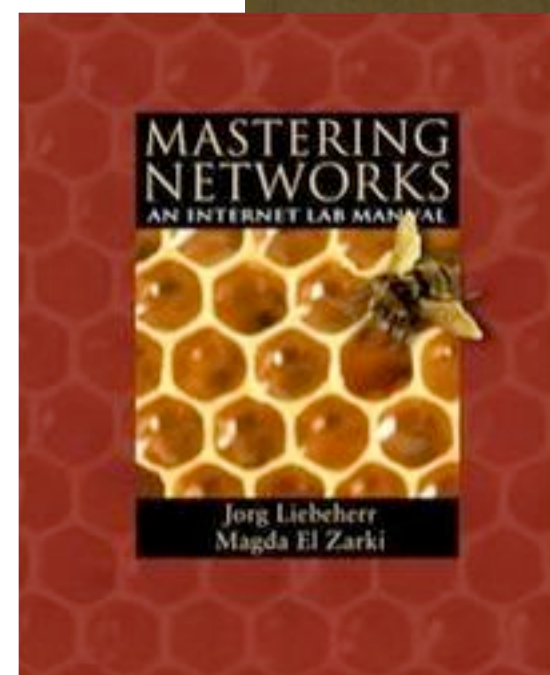


constantly improve

background



the beginning



The command to add a host route to IP address 10.0.2.31 with the next hop set to 10.0.1.21 is

```
PC1#route add -host 10.0.2.31 gw 10.0.1.21
```

The command to add the IP address 10.0.4.4 as the default gateway is done with the command

```
PC1#route add default gw 10.0.4.4
```

The commands to delete the entries created with the above commands are

```
PC1#route del -net 10.0.2.0 netmask 255.255.0.0
PC1#route del -host 10.0.2.31
PC1#route del default
```

There is no simple way to delete all entries in the routing table. One method to flush the routing table is to disable the interface and then enable the interface, as in

```
PC1# ifconfig eth0 down
```

When the commands are issued interactively in a Linux Shell, the added entries are valid until Linux is rebooted. To make static routes permanent, the routes need to be entered in the configuration file `/etc/sysconfig/static-routes`, which is read each time Linux is started.

The following commands are helpful to get information on routing and to find mistakes in the routing setup:

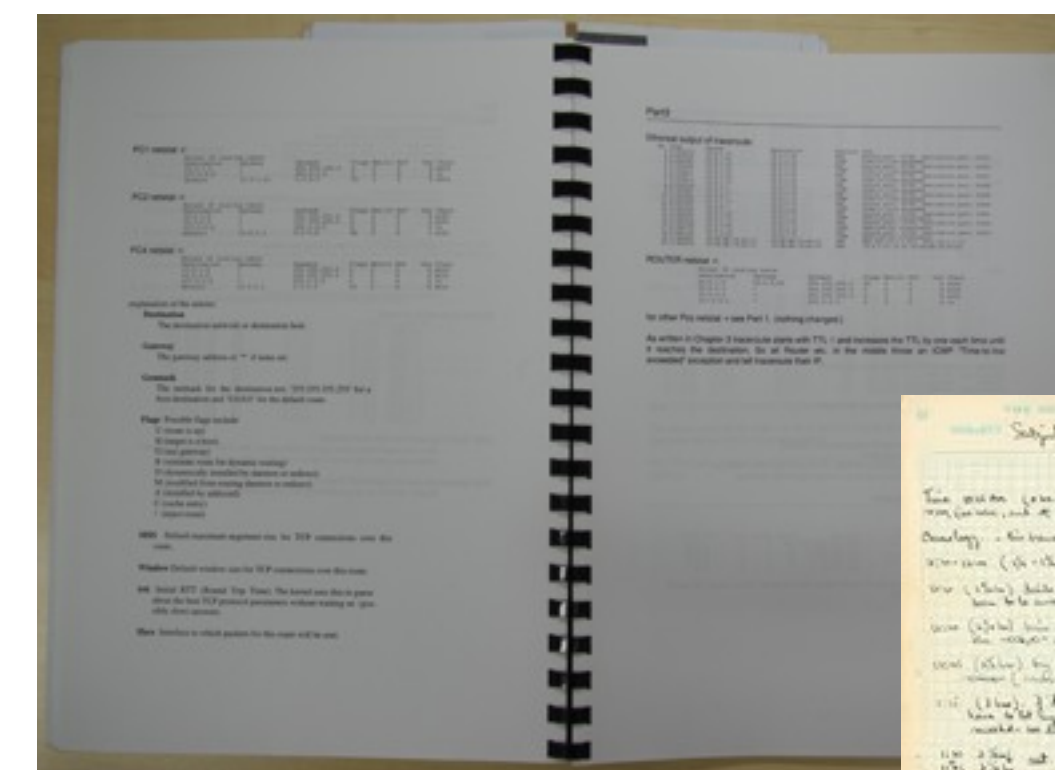
```
ping IPaddress Tests if IPaddress can be reached.
traceroute IPaddress Displays the route to the interface IPaddress.
```

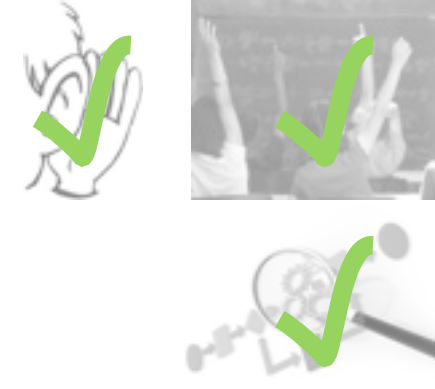
1. Configure the routing table entries of PC1 and PC4. You can either specify a default route or you insert separate routing entries for each remote network. For this exercise, add a route for each individual remote network. As a hint, here is the configuration information for PC4:


```
PC4#route add -net 10.0.2.0 netmask 255.255.255.0 gw 10.0.3.1
PC4#route add -net 10.0.1.0 netmask 255.255.255.0 gw 10.0.3.1
```
2. Configure the routing table entries of the IP router PC2. (The correctness of the routing entries will be tested after Router1 has been setup.)
3. Display the routing table of PC1, PC2, and PC4 with `netstat -rn` and save the output.

Lab Report:
Include the saved output of the routing table. Explain the entries in the routing table and discuss the values of the fields for each entry.

LAB 3 - PAGE 9

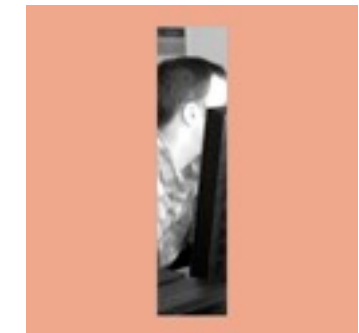
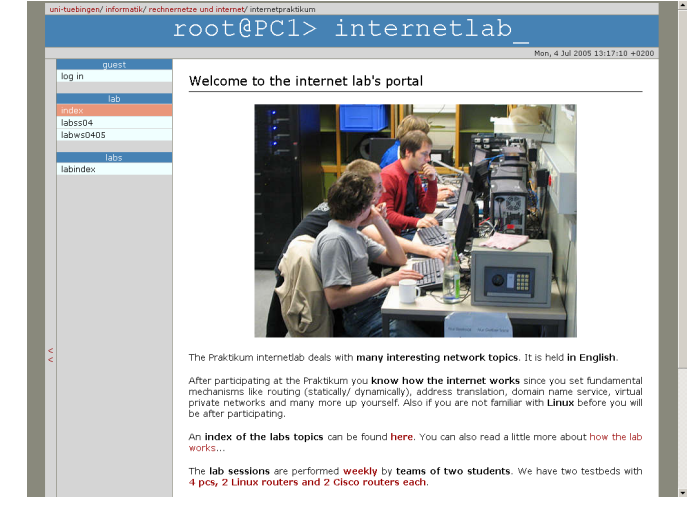




constant improvement



internetpraktikum



ilab

ilab2

part II - for master

part I - for bachelor

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

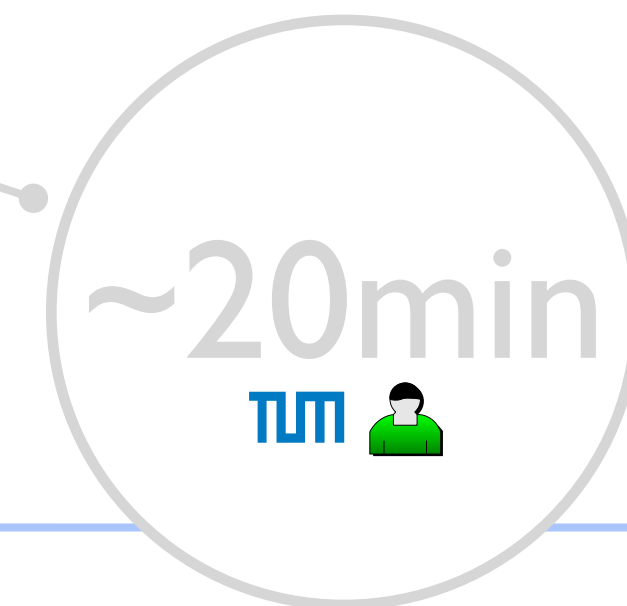
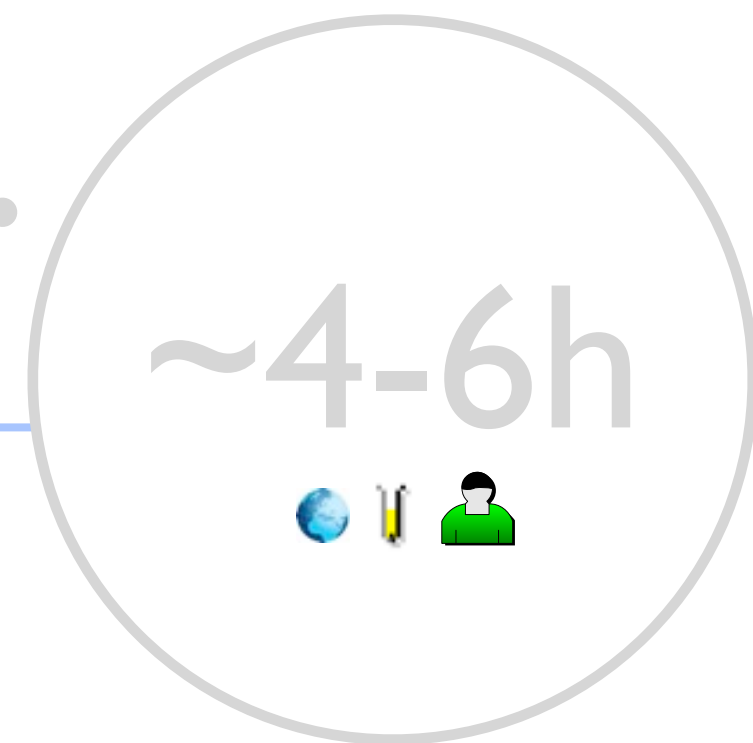


didactic concept

blended learning concept

Practical Teamwork

Lecture



Individual Oral Exam

Individual Preparation

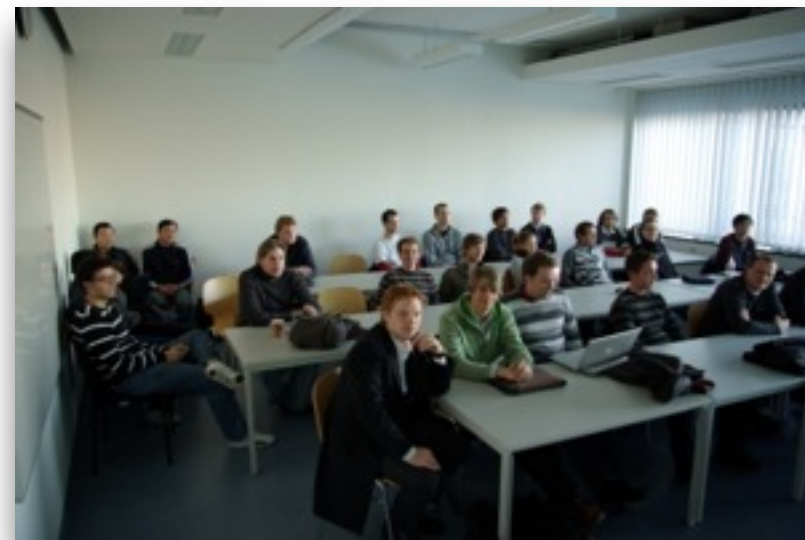




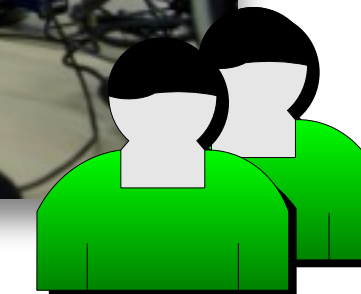
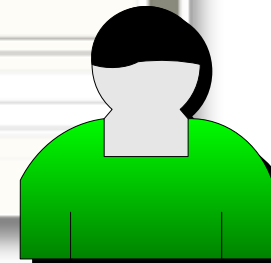
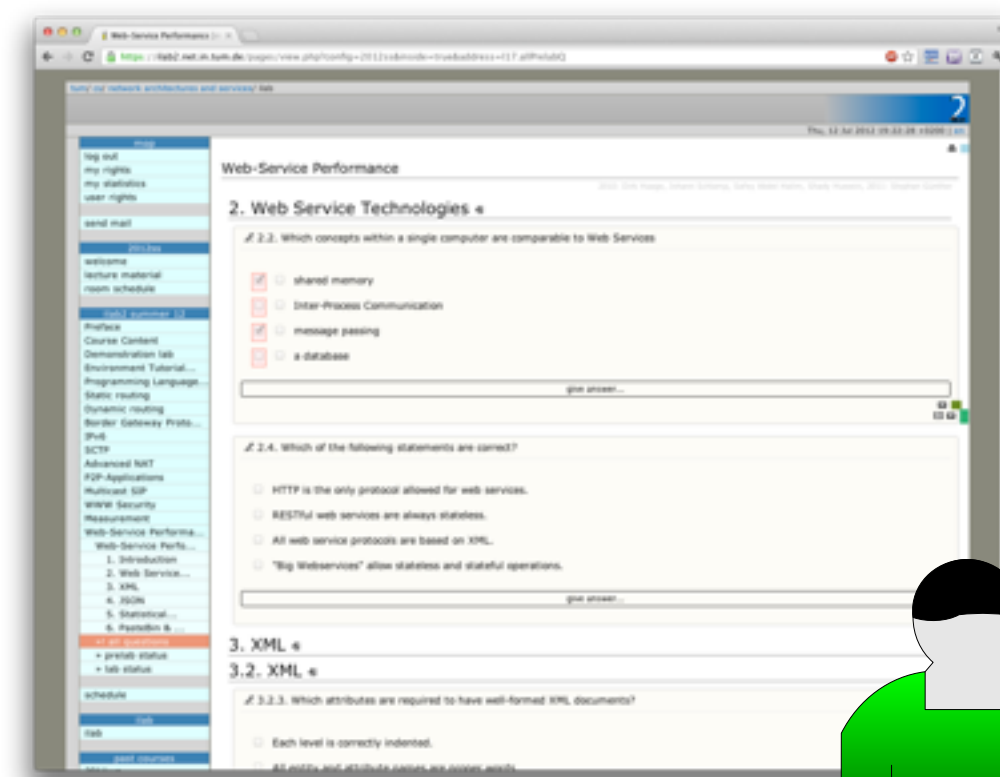
eLearning support

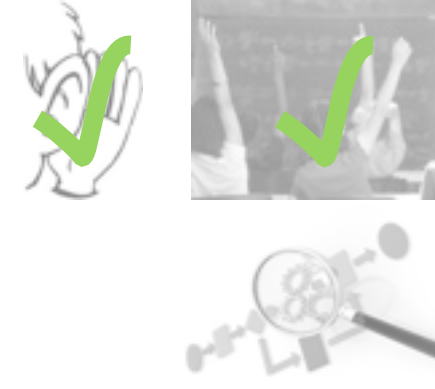
Individual Preparation

Lecture



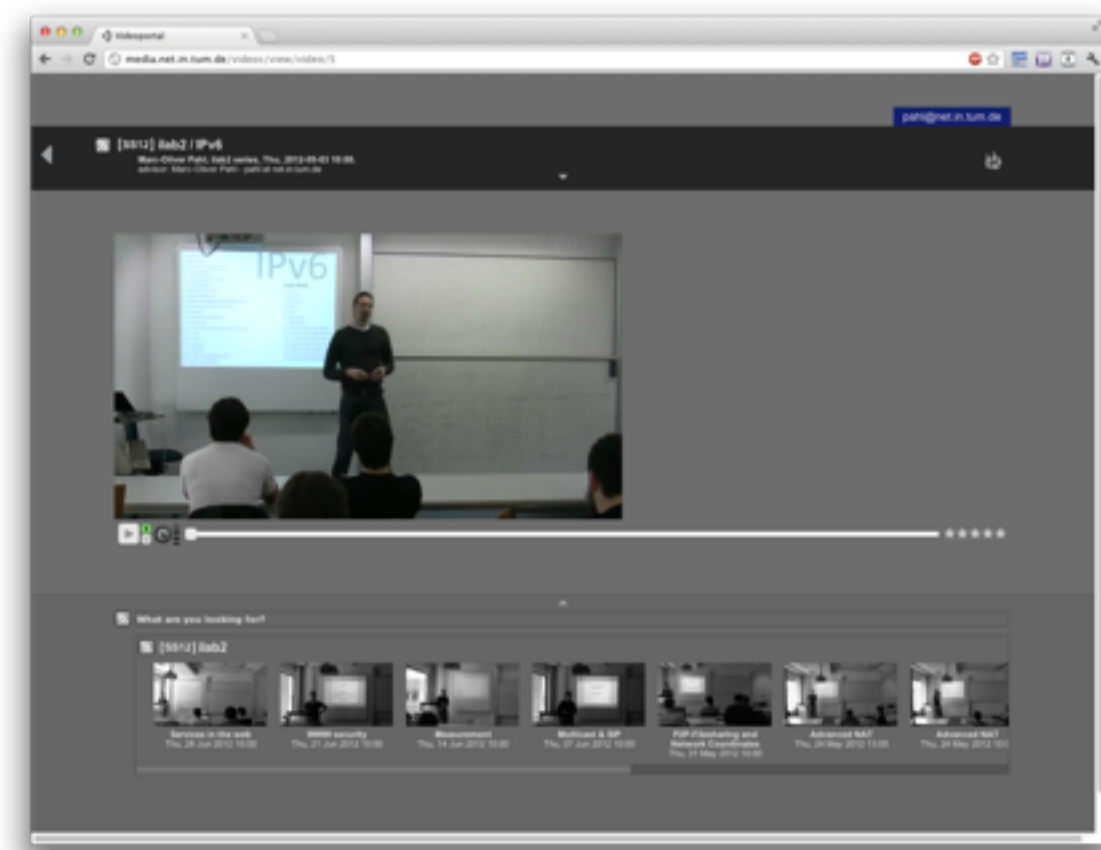
Practical Teamwork





eLearning prelab

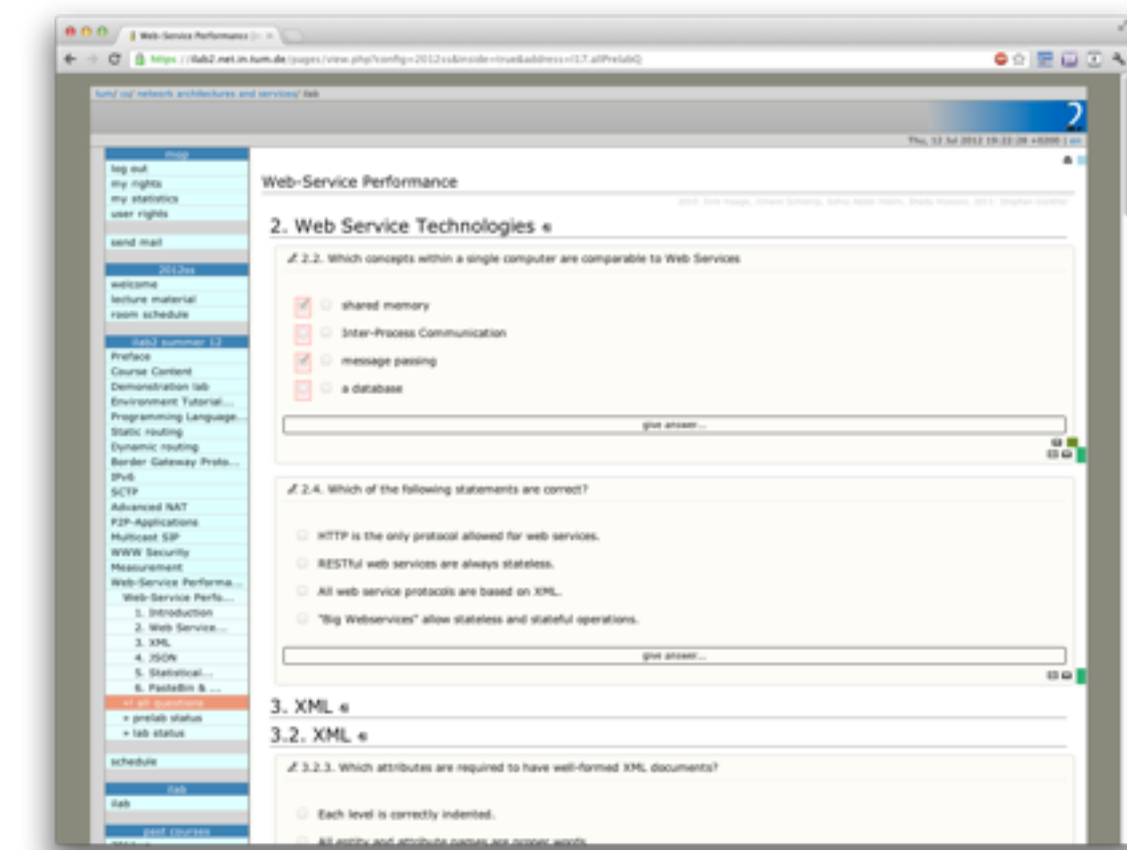
not taken into account for grading
(directly learn from errors)



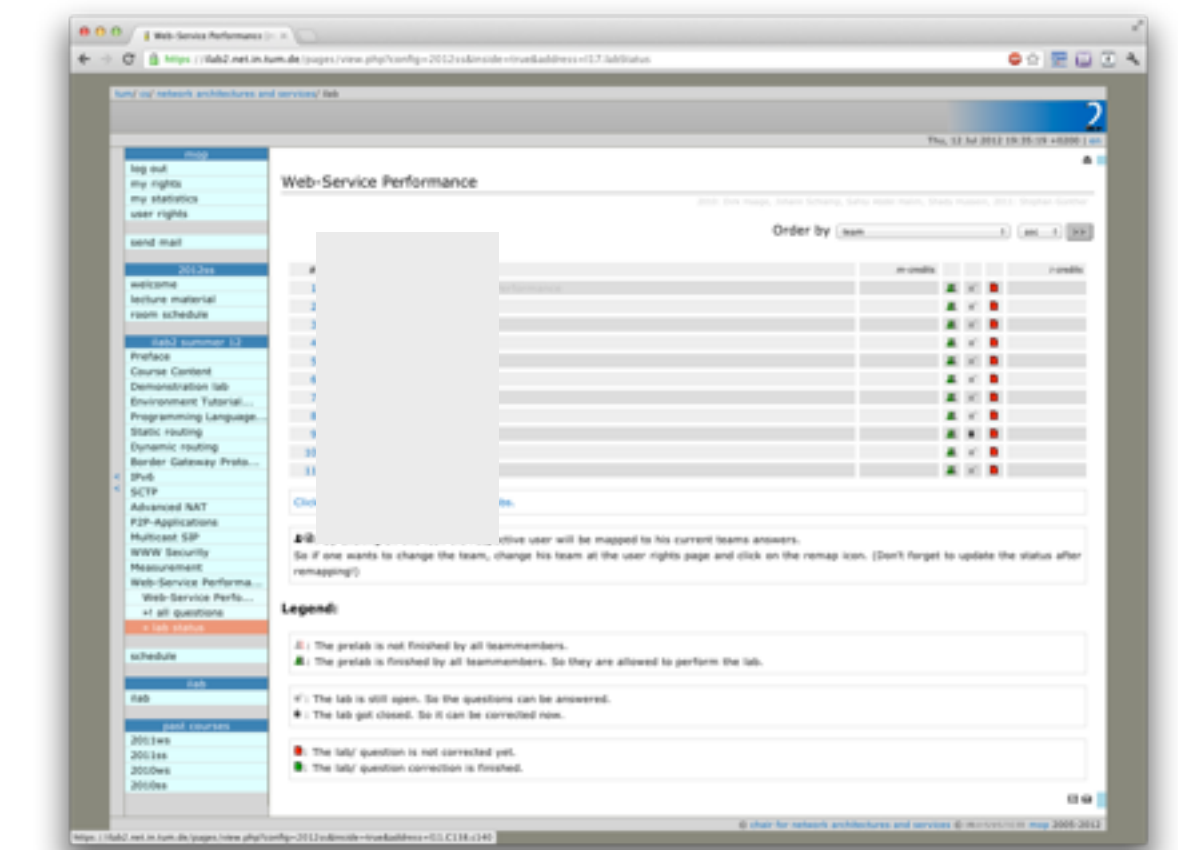
lecture recording



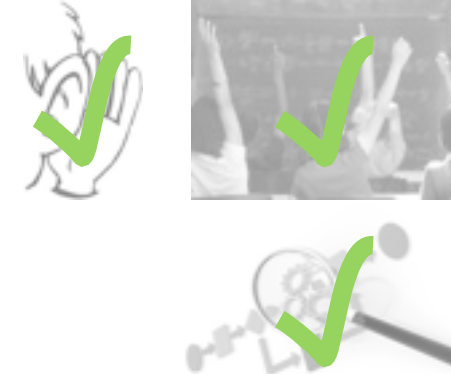
preparation texts



multiple-choice
motivation

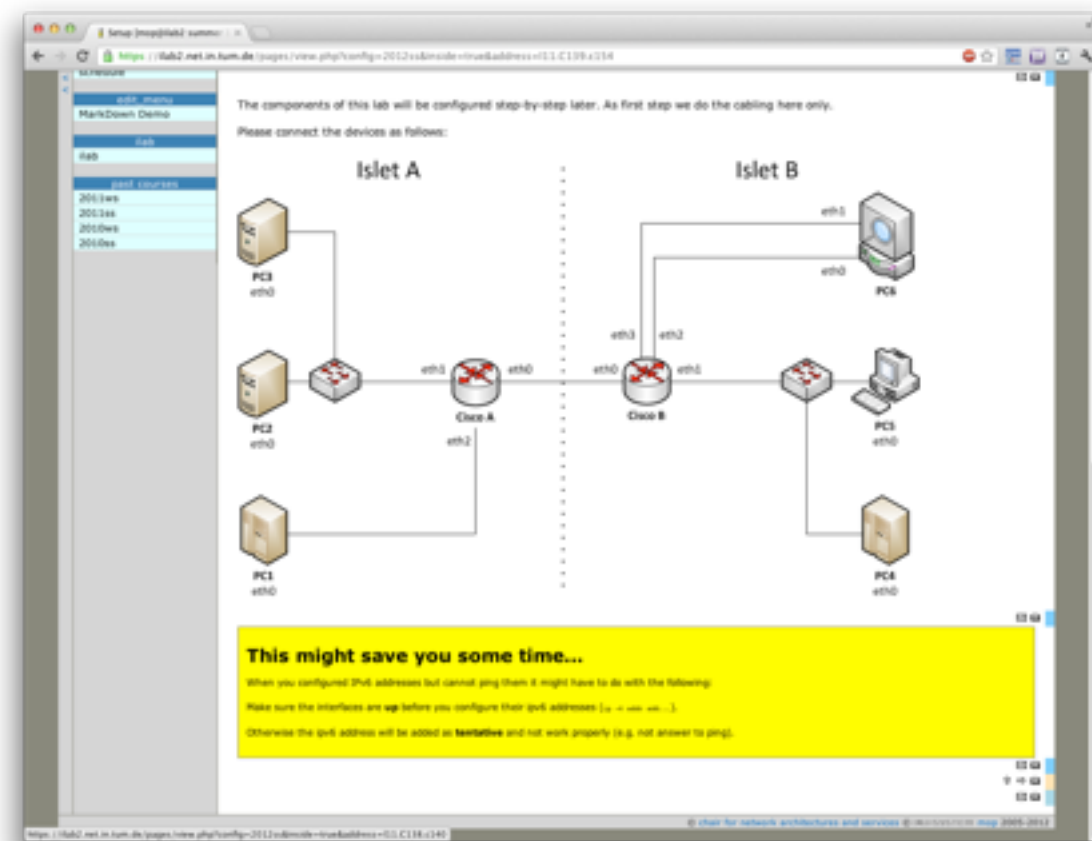


ranking +
who did not
finish?

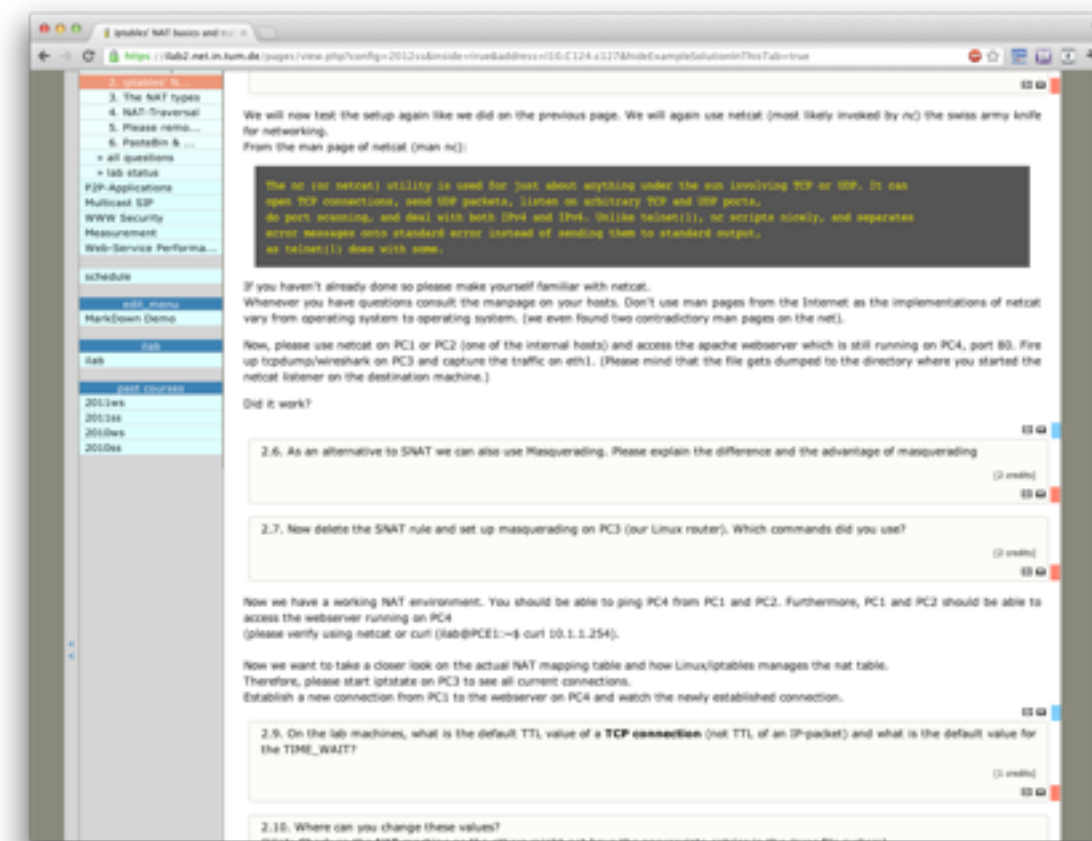


eLearning lab

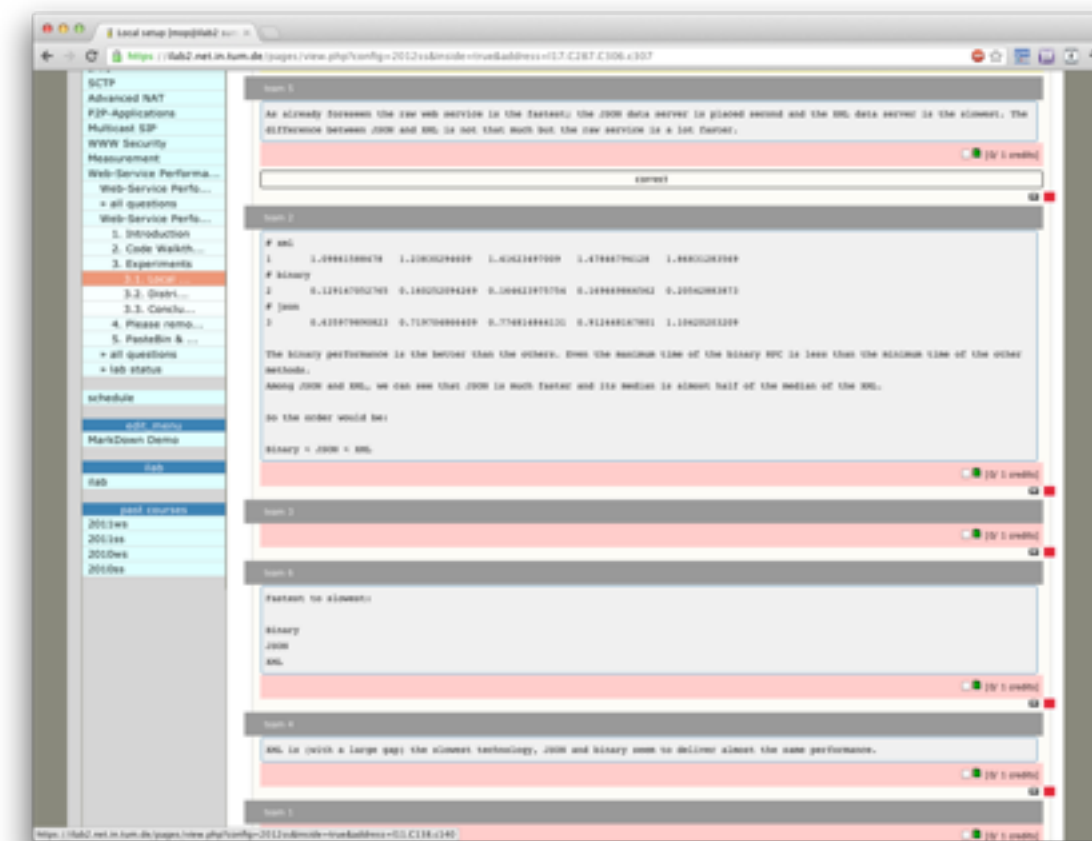
credits for grading



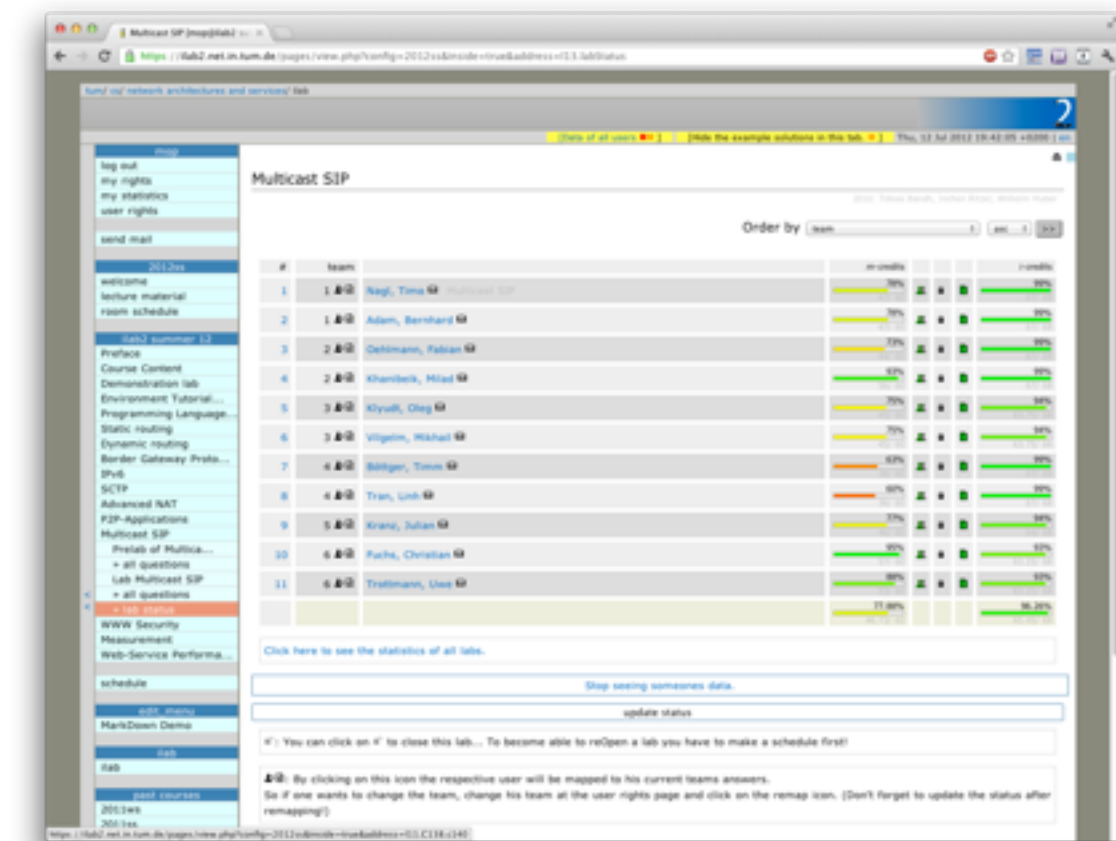
all instructions
online



free text inputs
inline



cross correction

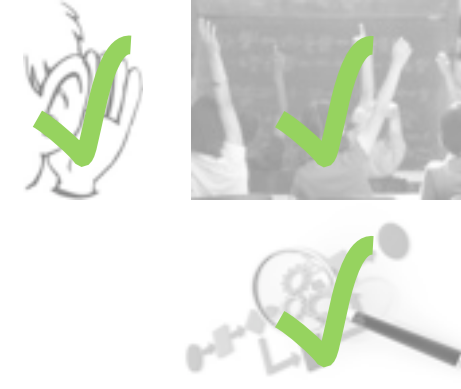


course management

no additional reports

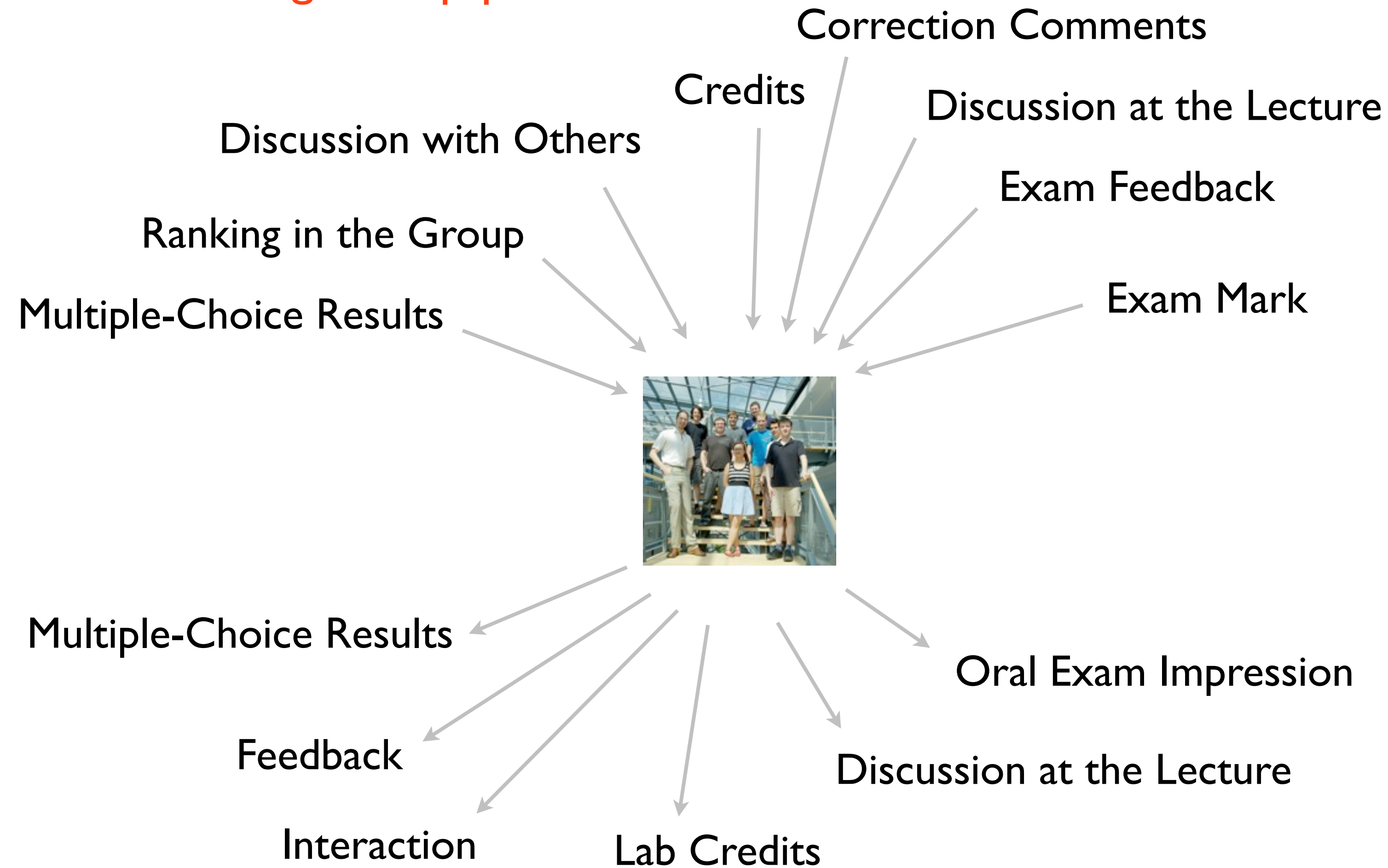
fast feedback

important **success factors**



interactivity

Self-Learning Support



Feedback is important to encourage the learners to continue learning. It is a main mean for motivation. Feedback is important for the teachers as well as it helps them to adapt to the needs of the current student group. The student feedback is continuously used to improve the exercises.

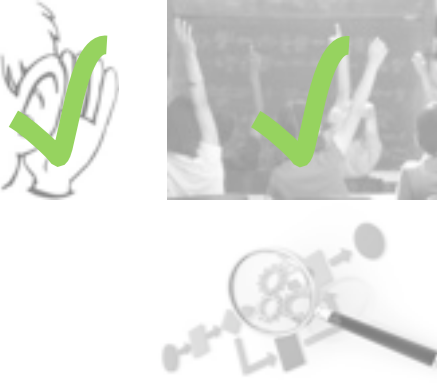
Feedback to the Teachers



frequent change

variation

in learning methods and modes



iLab

= online + live

instructions, self-correcting multiple-choice questions, free text inputs, course management, mail support, chat

lecture, hands-on, discussion



iLab

= group + individual + team

lecture

self-preparation

hands-on

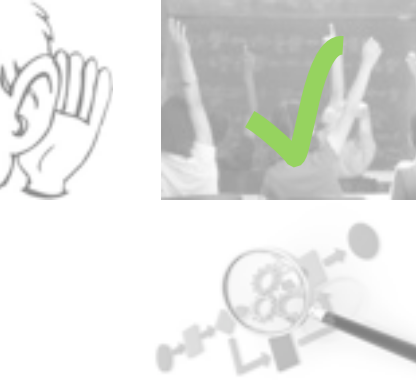


teamwork

you are not alone

learning from and supporting the team mate

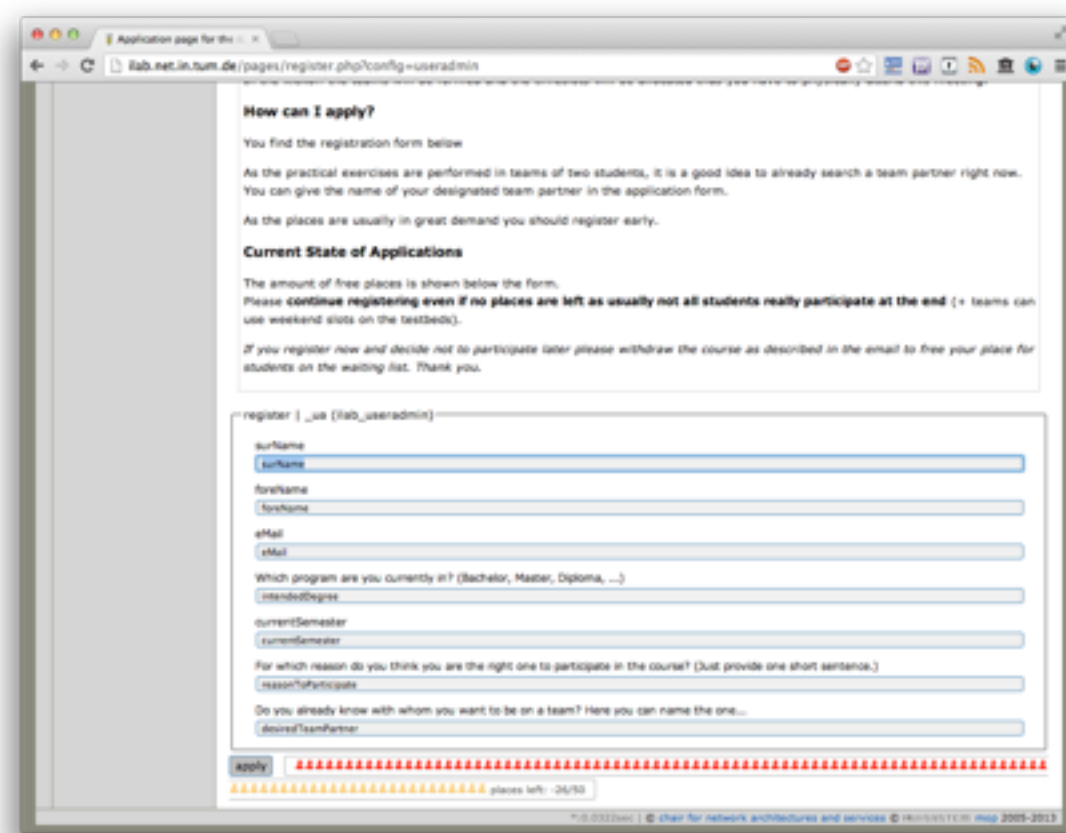




further encouragement



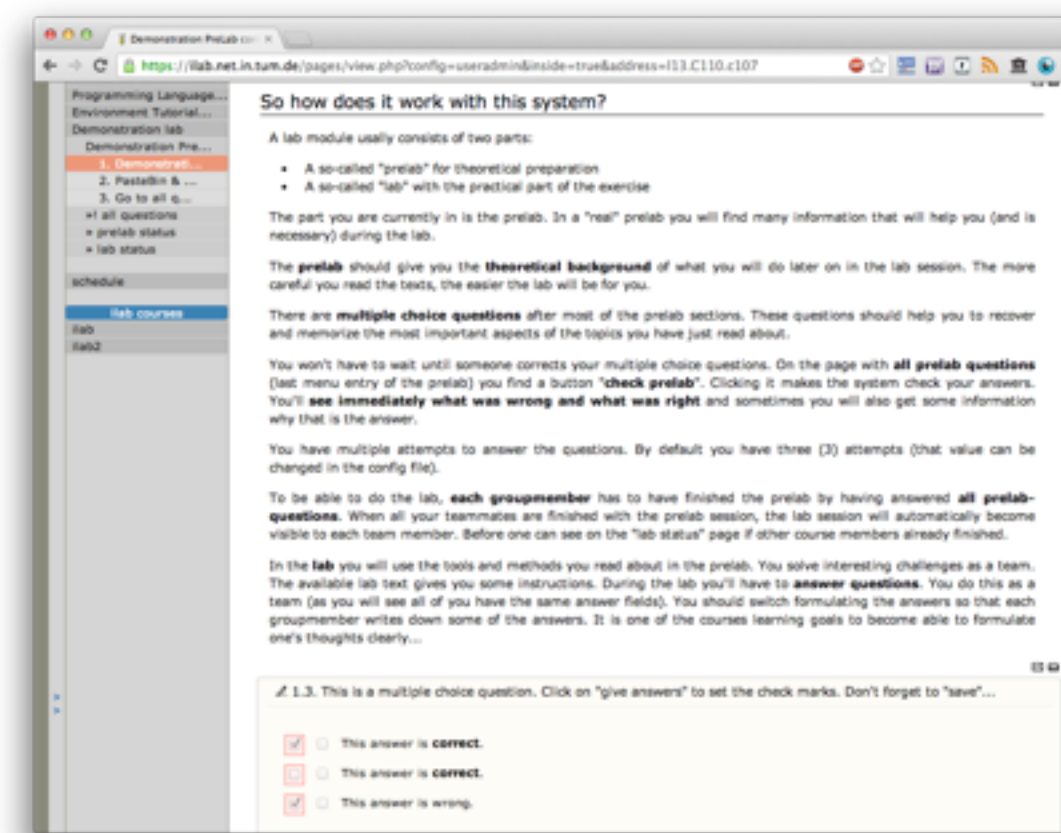
eLearning registration



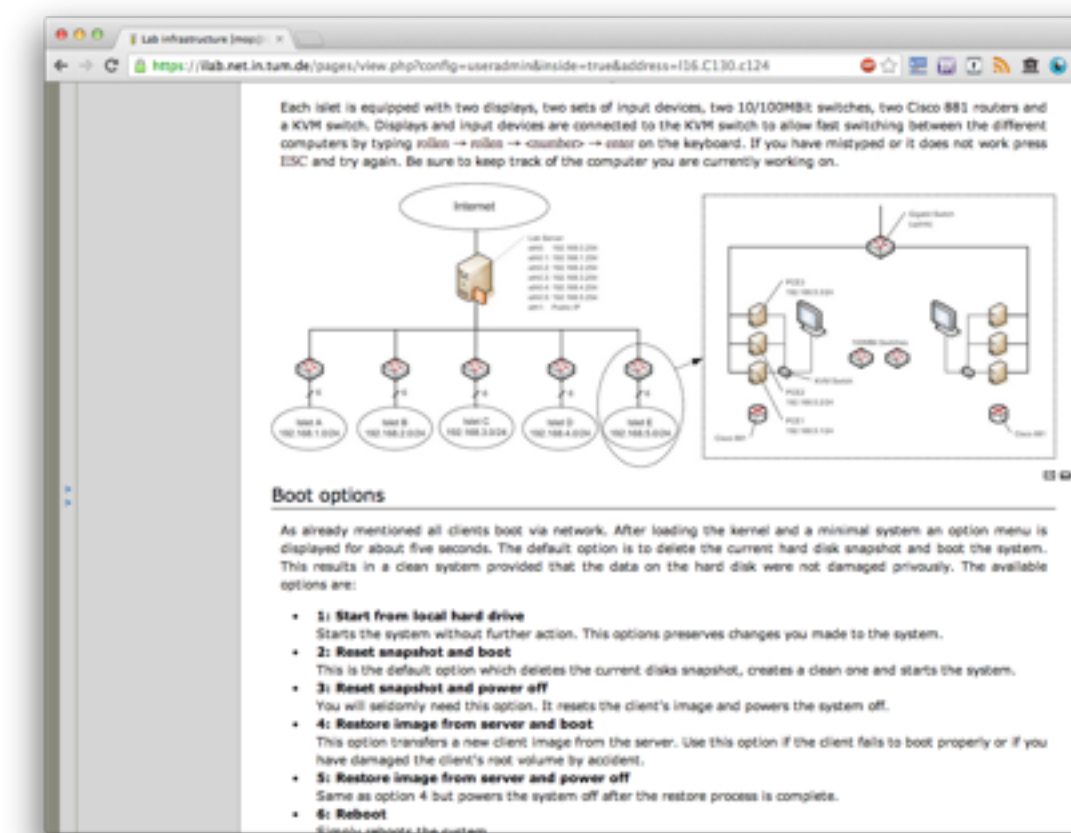
registration



immediate access



tutorials web-based
lab system



tutorials
environment
/ basic tools

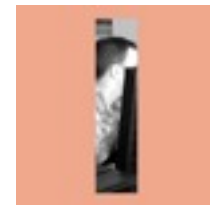


feel at home





topics

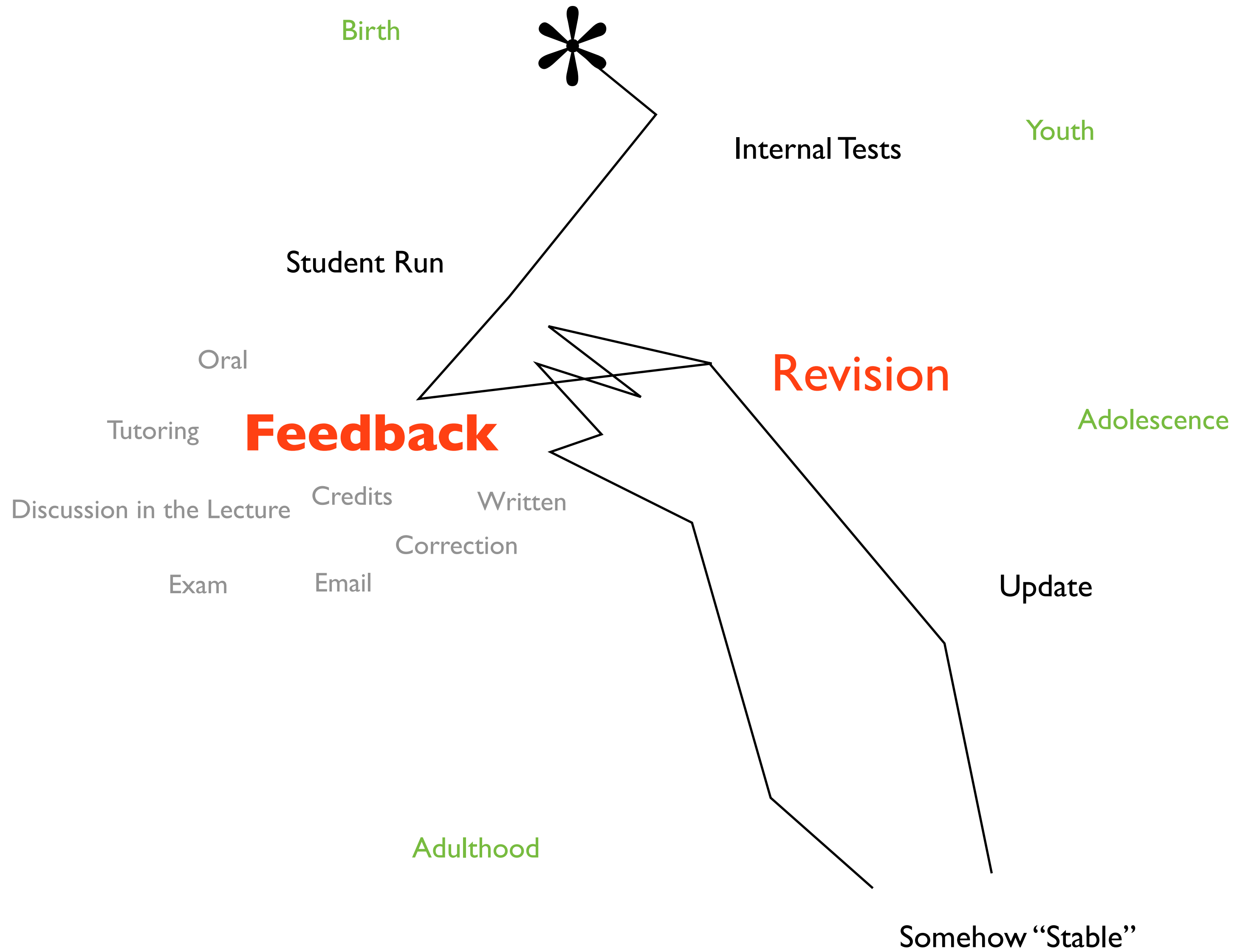


- a **Demonstration lab** - This lab module makes you familiar with the web-based learning system and the didactical principles behind the course.
- b **Cisco IOS Tutorials** - This tutorial give an introduction into the programming languages used in iLab2 (C, Java, Python). It also introduces the basics of Cisco IOS.
- c **Environment Tutorial Lab Room** - This tutorial introduces the lab room environment.
- 0 **The basics** - Our main concern in the first lab exercise is to get familiar with the basic tools we are using. You'll have a look at Linux' network capabilities experimenting on Layer 2 and 3 of the ISO-model.
- 1 **Static routing** - Continuing on Layer 3 we have a deeper look into IP-Routing.
- 2 **Dynamic routing** - On our journey towards the "real Internet" we learn how automatic routing works inside the different domains of the net.
- 3 **TCP/ UDP** - After looking at IP fragmentation, we climb up one Layer to Layer 4: The end-to-end-communication is of our interest now.
- 4 **DNS** - Most of the time we address machines using names instead of (IP-)numbers... but how does the Domain Name System work? After this lab you should know exactly what happens, when you type <http://ilab.net.in.tum.de> into your browsers url-field...
- 5 **NAT/ DHCP/ IPv6** - Coming closer to our home setup we look inside Network Address Translation as technique to use one external address to allow multiple intern machines to access the Internet. NAT is especially important today since we are getting out of Ipv4 addresses. Besides its usefulness NAT causes some trouble as we will see. Another important mechanism is Dynamic Host Control Protocol allowing computers to be partly automatically configured. As the migration towards Ipv6 is ongoing and since the new protocol provides interesting mechanisms we have a look at it here.
- 6 **Security I** - In this lab we get to know how Firewalls help to secure our network-nodes. As example we use a webserver using TLS.
- 7 **Security II** - How can we establish secure connections over insecure networks?
- 8 **Wireless LAN** - Often used but how is it really working? We address physical aspects as well as protocol aspects before we come to security. We will explore how fast we can crack a WEP-Key and more important why. We will look at WPA and Radius for a more secure wireless infrastructure.



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- 0 **Dynamic routing** - On our journey towards the "real Internet" we learn how automatic routing works inside the different domains of the net.
- 1 **Border Gateway Protocol** - This lab is about the Border Gateway Protocol (BGP) that is used for routing between Autonomous Systems (AS). You will learn about the power of the system and the risks of configuration errors...
- 2 **IPv6** - In this lab different features of IPv6 are examined: Autoconfiguration, DHCPv6, NAT64, Fragmentation, and Dual Stack implementation. Additionally a DNS Server running with IPv6 and IPv4 addresses and automatic Zone transfer is configured.
- 3 **SCTP** - You will get to know the features of SCTP realizing a video streaming example.
- 4 **Advanced NAT** - You will explore advanced NAT traversal techniques in this exercise.
- 5 **WWW Security** - In this lab, you are going to investigate some of the most important security challenges on the WWW. You will hack a Web server using a number of attack techniques, working your way through SQL Injection, Cross-Site Scripting and Remote Code Execution until you gain shell access to the server and can manipulate the file system.
- 6 **Multicast SIP** - In the first part of this PreLab you will learn about IP Multicast and the protocols used by it, IGMP and PIM. The second part is about SIP, the Session Initialisation Protocol, and how it is used, both in voice over IP and other applications.
- 7 **Measurement** - This lab is about passive traffic measurements and the export of measurement data from a monitoring probe to a remote traffic analyzer using the IPFIX protocol.
- 8 **Advanced Wireless LAN** - Defend my wireless territory - Do you have problems with overcrowded frequency bands for WLAN? The ilab2 can help you! This lab will address multiple aspects of WLAN, focusing on the protocol, especially on management and its flaws.
- 9 **Smart Space Orchestration** - Physical spaces that are enriched with networked sensors and actuators are called smart spaces. In this exercise you will build your own smart device, write a protocol for communicating with it, write a driver that connects your device with the ds2os middleware, and create user application services that orchestrate your space using your device.

continuous evolution



iLab exercises grow from continuous exchange. Exchange within the group of learners and between the students and the professors. The iLab encourages to exchange wherever possible. It is an important element of the success of the concept.

outlook

context related chat

2. iptables' N...

3. The NAT types

4. NAT-Traversal

5. Please remo...

6. PasteBin & ...

» all questions

» lab status

P2P-Applications

Multicast SIP

WWW Security

Measurement

Web-Service Performa...

schedule

edit menu

Markdown Demo

ilab

past courses

2011ws

2011ss

2010ws

2010ss

We will now test the setup again like we did on the previous page. We will again use netcat (most likely invoked by `nc`) the swiss army knife for networking.

From the man page of netcat (man `nc`):

```
The nc (or netcat) utility is used for just about anything under the sun involving TCP or UDP. It can open TCP connections, send UDP packets, listen on arbitrary TCP and UDP ports, do port scanning, and deal with both IPv4 and IPv6. Unlike telnet(1), nc scripts nicely, and separates error messages onto standard error instead of sending them to standard output, as telnet(1) does with some.
```

If you haven't already done so please make yourself familiar with netcat. Whenever you have questions consult the manpage on your hosts. Don't use man pages from the Internet as the implementations of netcat vary from operating system to operating system. (we even found two contradictory man pages on the net).

Now, please use netcat on PC1 or PC2 (one of the internal hosts) and access the apache webserver which is still running on PC4, port 80. Fire up tcpdump/wireshark on PC3 and capture the traffic on eth1. (Please mind that the file gets dumped to the directory where you started the netcat listener on the destination machine.)

Did it work?

2.6. As an alternative to SNAT we can also use Masquerading. Please explain the difference and the advantage of masquerading [2 credits]

2.7. Now delete the SNAT rule and set up masquerading on PC3 (our Linux router). Which commands did you use? [2 credits]

Now we have a working NAT environment. You should be able to ping PC4 from PC1 and PC2. Furthermore, PC1 and PC2 should be able to access the webserver running on PC4 (please verify using netcat or curl (`ilab@PCE1:~$ curl 10.1.1.254`)).

Now we want to take a closer look on the actual NAT mapping table and how Linux/iptables manages the nat table. Therefore, please start `iptstate` on PC3 to see all current connections. Establish a new connection from PC1 to the webserver on PC4 and watch the newly established connection.

2.9. On the lab machines, what is the default TTL value of a **TCP connection** (not TTL of an IP-packet) and what is the default value for the `TIME_WAIT`? [1 credits]

2.10. Where can you change these values?

mop> do not forget to look at the routing table of PC4 here!

u> good point :)

jan> Did anyone get this running?

silvie> sure. Though we had to resetup. Probably we had a bug. Maybe you have a similar problem.

automatic diffs in correction

The screenshot displays a web application interface for a performance comparison task. The left sidebar contains a navigation menu with categories like SCTP, Advanced NAT, P2P-Applications, Multicast SIP, WWW Security, Measurement, Web-Service Performance, and Experiments. The main content area shows five team submissions (team 1 to team 5) with their answers and automatic diff results.

Team 5: Answer: "As already foreseen the raw web service is the fastest; the JSON data server is placed second and the XML data server is the slowest. The difference between JSON and XML is not that much but the raw service is a lot faster." Diff: correct [0/1 credits]

Team 2: Answer: Includes a table of performance data for XML, binary, and JSON methods. The table shows binary is the fastest, followed by JSON, and XML is the slowest. The diff is correct [0/1 credits].

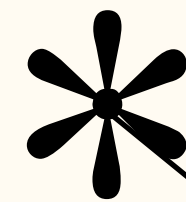
Method	1	2	3	4	5
# xml	1.09861588478	1.23830294609	1.41623497009	1.47846794128	1.86831283569
# binary	0.129147052765	0.160252094269	0.164623975754	0.169669866562	0.20542883873
# json	0.635979890823	0.719704866409	0.774814844131	0.912448167801	1.10420203209

Team 3: Answer: "Fastest to slowest: Binary, JSON, XML." Diff: correct [0/1 credits]

Team 4: Answer: "XML is (with a large gap) the slowest technology, JSON and binary seem to deliver almost the same performance." Diff: correct [0/1 credits]

Team 1: Answer: (Empty) Diff: correct [0/1 credits]

create your own exercise



Internal Tests

~1h
TUM

Introductory Lecture

didactic concept | authoring tutorial | topic selection | assignment review teams

Team Prepares Exercise

slides for talk | prelab | lab | slides | tutor support

~10-12h
TUM

Student Run

Revision

Feedback

~2h
TUM

Intermediate Presentation

presentation | feedback | quality alignment

Review & Update

review team feedback | revision

~10-12h
TUM

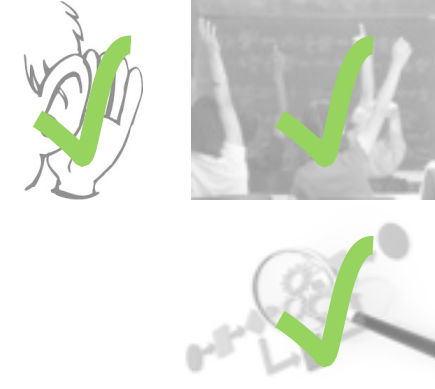
Somehow "Stable"

~2h
TUM

Final Presentation

how is it now | what did you change/ learn | your take home?

summary



in short



listen

variation: online + live
team work + individual
+ group
feedback



encouraging
environment

encourage



constantly improve

lots of happy faces



The iLab Experience

- <http://ilab.net.in.tum.de/>
Bachelor/ Master course
- <http://ilab2.net.in.tum.de/>
Master/ Bachelor course
- <http://labsystem.sf.net/>
eLearning environment (*open source*)
- **Marc-Oliver Pahl** | pahl@net.in.tum.de
<http://pahl.de/>

