

## A national e-learning platform for training specialists in Nuclear Medicine in Norway

Martin Biermann<sup>1,2</sup>

### Abstract

Specialist training in Nuclear Medicine in Norway is based on individual tuition supplanted by lecture-based courses in Nuclear Medicine and related disciplines, even though the limitations of the lecture regarding transferral of information are well-documented.

We have developed and implemented a new electronic course format that emphasizes the practice of Nuclear Medicine. The system utilizes a combination of three client-server platforms: (1) A web-conferencing platform, (2) a client-server imaging processing system for Nuclear Medicine, and (3) a Learning Management System (LMS). Each of the weekly 30 lessons in the planned new course "Practical Nuclear Medicine" will be introduced by a webcast lecture and live demonstration with audience feedback. The lecture will be recorded on a video archiving platform, and supporting material will be handed out via the LMS. Finally, course participants will process and read one or several anonymized original studies delivered via the imaging processing system and submit their reports via the LMS.

The new system is online under <https://nukit.ihelse.net/moodle>. The course has been approved by the Norwegian Medical Association and is due to be held in 2017.

### Keywords

Post-graduate education; Nuclear Medicine; e-learning; Learning management systems (LMS)

UPED-Skrift 2016/4, <http://hdl.handle.net/1956/11945>

### Introduction

Besides radiology, Nuclear Medicine is one of two specialties in the field of medical imaging. After completing medical school, physicians continue their medical education by completing a five-year residency in an accredited institution under the supervision of one or more nuclear medicine specialists [1,2]. In Norway, the training of Nuclear Medicine residents is governed by rules issued by the Norwegian Directorate of Health (*Helsedirektoratet*, HDir) advised by the Norwegian Medical Association (*Den norske legeforening*, Dnlf) [3].

The current system of educating medical specialists is based on individual tuition by way of master-apprentice (*mester-svenn*) supervision [4,5]. Individual training is supplanted by national bi-annual courses arranged under the auspices of the Dnlf. In Nuclear Medicine, residents are required to attend a total of 210 hours of course education. The following three courses of 30 hours each are obligatory: Radiation protection I and II

and Clinical Nuclear Medicine [3]. For the remaining 120 course hours of their course education, residents can choose among relevant courses arranged for other medical specialties such as radiology or internal medicine [3].

Under the chairmanship of the author since 2014, the Specialty Committee for Nuclear Medicine (SCNM) initiated a process of re-evaluating and updating the rules governing Nuclear Medicine training in Norway [3]. Direct feedback from residents was obtained by site visits to all nine accredited institutions between September 2014 and September 2015. The catalogue of required procedures 2003 was revised to include positron emission tomography (PET) [6]. The plenary course in Clinical Nuclear Medicine, introduced in 2008, was made obligatory in 2015.

Residents as well as supervisors complained that there was a lack of relevant courses in Nuclear Medicine compared with other specialties such as radiology. In particular, there was no course teach-

---

<sup>1</sup>Nuclear Medicine and PET centre, Department of Radiology, Haukeland University Hospital, N-5021 Bergen, Norway

<sup>2</sup>Section for Radiology, Clinical Institute I, University of Bergen, Bergen/Norway

---

### Address for correspondence:

Martin Biermann, Professor/Senior Consultant Physician, Nuclear Medicine/PET-centre, Department of Radiology, Haukeland University Hospital, N-5021 Bergen, Norway. [martin.biermann@uib.no](mailto:martin.biermann@uib.no)

ing the practicalities of Nuclear Medicine including post-processing of the raw image data. With support from the Norwegian Association for Nuclear Medicine (*Norsk forening for nukleærmedisin*, NFNM), members of the SKNM – Andreas Tulipan and the author – and of NFNM's steering committee – Katrin Weigel – took the initiative of launching a new national course called "Practical Nuclear Medicine". The course is to be based on a new information technology (IT) infrastructure that puts a focus on active learning.

The following is a description of the new national platform for teaching Nuclear Medicine implemented since October 2015.

## Related work

For teaching medical students at the University of Bergen, the author implemented a teaching database with anonymized patient studies on a dedicated image server based on a proprietary client-server system (Oasis; Segami Corporation, Inc., Columbus MD, USA) in 2011. The Oasis system had been used for processing and visualizing all Nuclear Medicine and PET data at the Nuclear Medicine/PET centre at Haukeland University Hospital (HUH) since 2009. For the medical course at HUS/UiB, approx. 100 patient studies covering the entire field of Nuclear Medicine were selected and saved on a dedicated server in anonymized format. Metadata – referral and original report – were saved on a separate intranet server inside the hospital network as static HTML pages.

Independently, Andreas Tulipan of Oslo University Hospital (*Oslo universitetssykehus*, OUH) launched a web conferencing platform for the mandatory intrainstitutional teaching (*internundervisning*) at OUH in 2013. Since Nuclear Medicine at OUH is split over three campuses, there was a need for a scalable audio video (AV) streaming solution. The chosen solution was WebEx (<https://www.webex.com>; Cisco Systems, Inc., San Jose CA, USA). A presenter at one of the participating institutions gives a 45-minute lecture on a topic in Nuclear Medicine with live feedback from the audience at the other institutions. This solution has proved to be popular. In 2015, the solution was scaled up to include all Norwegian sites for Nuclear Medicine. A central rotation plan covering all major topics over the course of two years ensures that all institutions contribute.

## Course design

In devising the course, the course committee (Katrin Weigel, Andreas Tulipan, and the author) set out to extend the format of the weekly on-line teaching sessions introduced in 2013. In addition to the introductory lecture and ensuing live discussion, we sought to include a hands-on element based on the teaching image database established at UiB in 2011.

Each lecturer will be asked to give an introductory presentation of about 20 – 25 min shared in a common session on the web conferencing system. The presentation will be archived on a video sharing system such as Vimeo (<https://vimeo.com>) or YouTube (<https://www.youtube.com>), so that it will be available online for future reference and for viewing on mobile devices. Each lecturer is to choose one or more anonymized cases on the teaching server or upload anonymized teaching cases from his/her own institution. The course participants are then given the assignment to report on these studies until the next course day. The reports will then be reviewed and graded by the lecturer. Since the teaching data in the course are real patient studies (albeit in anonymized format), the system has to preclude unauthorized access and meet all requirements to data security posed by current legislation as well as local and regional data protection agencies.

## System description

*System design.* Based on the above considerations, the system was split into three components: (1) Video conferencing system for plenary lectures and live audience feedback, (2) teaching image database, and (3) Learning Management System (LMS) for handling the interaction between students and teachers.

*Ad 1:* Microsoft Lync was chosen as the web conferencing platform. There is already an established infrastructure between HVIKT, *Helse Nord IKT* and *Helse Midt-Norge IKT* that allows live video conferencing between three of the four health regions meeting all IT security requirements. *Sykehuspartner*, the IT provider for the South Eastern health region, is now establishing Lync in connection with the roll-out of Microsoft Windows 7. Lync allows screen sharing with a live AV channel from all hospital machines that have installed the Lync client. In addition to webcasting meetings, Lync will provide a secure channel for ad-hoc communication including screen sharing between all course participants. Lync sessions can be streamed to a

video file on the local host, which then can be uploaded to a video sharing service.

*Ad 2:* The teaching database of anonymized cases is identical to the database that has been used to teach medical students at UiB since 2009/2011. Teachers can choose to teach with the existing cases from HUH, but are encouraged to expand the database by uploading cases from their own institutions. So that course participants can process the teaching cases, each institution will need to install Segami Oasis client software on a compatible workstation. The client licences are provided centrally from the Oasis server.

*Ad 3:* Moodle was chosen as the LMS because it is free and easy to implement. To allow for functionality that is not covered by Moodle, MDCake, a generic data management system developed by the author, was installed under the same PHP framework [7].

The technical details of the implementation are covered in Appendix A.

*Certification.* The above solution was certified by HVIKT on 25 November 2015 and approved by the data protection officer (*personvernombudet*) in Helse Bergen. The proposed course “Practical Nuclear Medicine: Organ imaging” was approved for specialist training in Nuclear Medicine and in Radiology by Dnlf in January 2016, counting for 30 hours in each specialty.

## Results

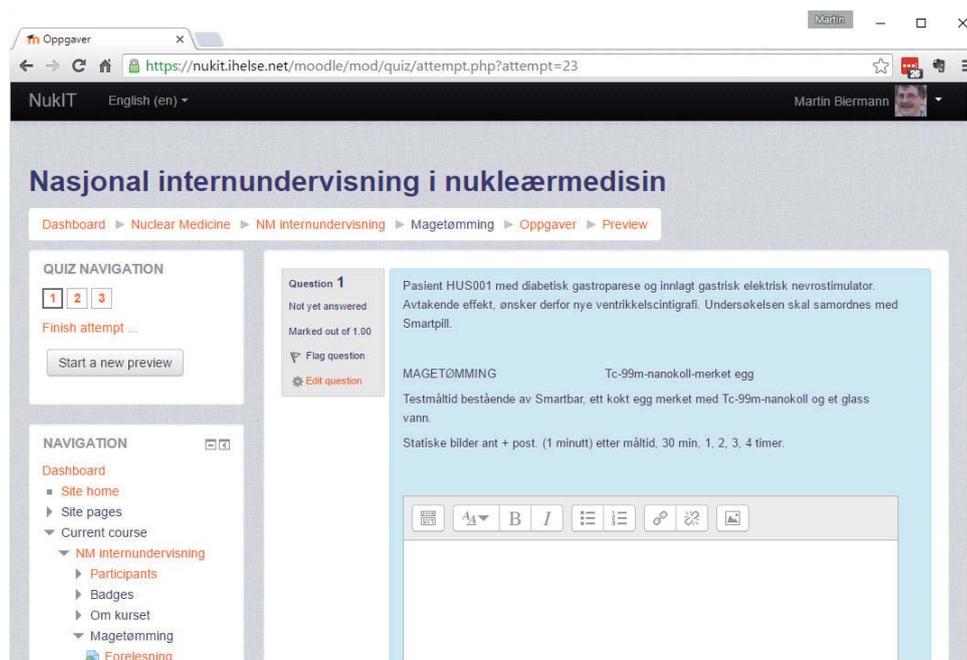
The new national teaching server for Nuclear Medicine, <https://nukit.ihelse.net> (Figure 1), has been online since December 2015. All Nuclear Medicine residents in Norway are enrolled on the LMS.

A test lesson on gastric emptying was held as part of the weekly national Nuclear Medicine teaching on 7 December. The lesson material consisted of four elements: (1) Webcast, (2) supplementary teaching materials, (3) assignment, and (4) discussion forum.

1. The webcast included a lecture based on Microsoft Powerpoint slides and a live demonstration of post-processing a typical Nuclear Medicine gastric emptying study on the Oasis system. The Webcast was archived on the WebEx server.
2. Supplementary Teaching material included the lecture handouts in Portable Document Format (PDF), suggested reading (Society of Nuclear Medicine guidelines), and the link to the WebEx archive of the webcast.

3. The assignment was to process three typical gastric emptying studies (one normal, two abnormal) on the Oasis system. The task was implemented as an essay question in the Moodle LMS (Figure 1). Clinical information (age of the patient, clinical history and relevant diseases such as diabetes) was presented in the same format that would be encountered in everyday practice of Nuclear Medicine. In addition, the case vignette included information on the imaging protocol (type of test meal, camera, time points of the images). In order to carry out the assignment, the course participant had to follow the same workflow as in a Nuclear Medicine department. First, the image data need to be loaded into the Nuclear Medicine post-processing system (Figure 2). After looking at the images, a region of interest (ROI) is drawn around the full stomach directly after the radioactive test meal. Gastric emptying is then quantified by calculating the retention of radioactivity in the stomach over time. Finally, the student needs to establish the correct diagnosis in light of the image data and the clinical information. For each case, the student is to write a report in free text format. When the participants have submitted the text of their reports, the LMS will immediately display the original clinical reports given at the time of the patient study so as to provide instant feedback. The essay questions include grading information so that questions in the LMS can be re-used by other lecturers. When a course participant fails to report a given study adequately, the participant will be presented with a new case from the image database so that he/she is given a second chance to pass the course module.
4. A moderated discussion forum was provided to encourage reflection and critical thinking. Course participants can raise questions that are not addressed in the Webcast, dispute the original reports given at the time of the actual patient study, or discuss challenging issues based on their own practice.

Feedback from the target audience has been encouraging so far. A second lesson on radioiodine therapy of thyroid cancer was given on 25 April based on the same format. A more formal evaluation of the system is planned when the system has been fully implemented with connectivity to all nine institutions in all four health regions.



**Figure 1.** A typical assignment in the new course “Practical Nuclear Medicine” on the new e-learning portal at <https://nukit.ihelse.net>. The course participant is asked to write a report on study “HUS001” on the image database server on the background of the clinical and protocol information provided.

## Discussion

Lectures are an inefficient medium for the transfer of information in education [9]. This is exemplified by a recent study by Lautrette et al.: Of three teaching points in a series of 13 lectures on intensive care medicine, only 4 % of 367 junior physicians demonstrated understanding of all three teaching points on evaluation forms collected immediately after each lecture, while 21 % missed the main messages completely [10].

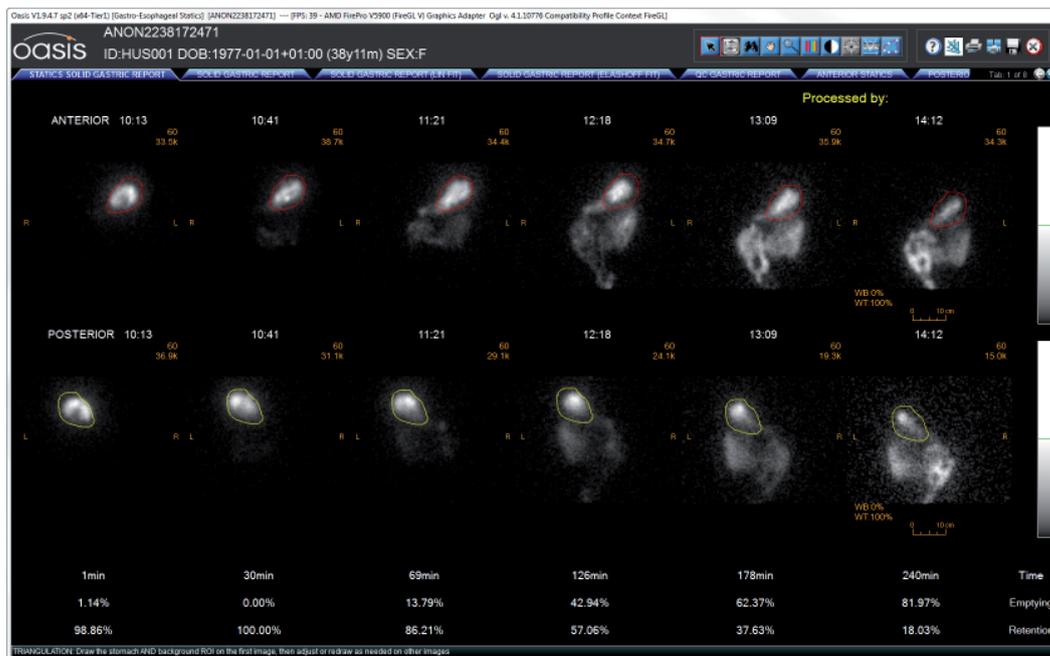
Given the well-documented limitations of lectures, it is surprising to note that nearly all specialist training outside the realm of direct tuition is lecture based. Taking a fresh look at the curriculum for Nuclear Medicine residents in Norway we noted that there was a lack of courses that taught residents their main occupation as specialists – how to process and visualize nuclear medicine studies and how to write a meaningful report based on the images and clinical information. By supplanting the already established format of weekly broadcasted meetings with a client-server image database and an LMS, we have defined a new course format which puts the emphasis on active learning and problem solving skills [11]. The new platform is online and can be utilized in all medical imaging specialties.

The traditional system of educating medical specialists has recently been challenged in a white paper by HDir [12]. The main criticism was that the established system was too static and did not

take into account modern didactics. HDir proposes a shift to competency modules that are based on predefined learning outcomes rather than number of procedures or time spent practicing a speciality at an accredited institution [12,13], and intends to establish training centres [14] with phantoms for common medical procedures such as endoscopy or surgery (*ferdighetslaboratorier*) at all university hospitals in addition to national e-learning platforms [12,13].

In this context, the proposed course architecture can be seen as a virtual simulation centre for medical imaging. There is already a growing number of e-learning platforms for Nuclear Medicine on the Internet, e. g. <http://www.escanacademy.com>. None of the platforms known to us present images in diagnostic quality, and no platform includes all the processing tools needed for the various modality and/or organ-specific protocols in Nuclear Medicine. Since Oasis also includes all visualization tools needed for radiology, incorporation of radiological cases for teaching subspecialty courses such as paediatric radiology is easily accomplished.

Limitations. (1) The new system is still in a prototype phase. The web conference infrastructure (Microsoft Lync), a backbone of the proposed course in Nuclear Medicine, currently covers only three of the four health regions. The start of the first course in Practical Nuclear Medicine may thus be delayed to early 2017. (2) While the image database (Segami Oasis) is in active use in the Western



**Figure 2.** Screenshot of case “HUS001” (same as in Figure 1) when it is loaded in the Oasis client. For quantification of gastric emptying, a region of interest (ROI) is drawn around the stomach directly after the radioactive test meal. The images taken over the next four hours show considerable delay in gastric emptying due to diabetic gastroparesis.

Health Region in all teaching contexts, there are still issues with connectivity from the other health regions. (3) The choice of LMS is arbitrary. Since January 2016, UiB has launched Canvas as its own open-source LMS. The author has begun implementing course material for medical students on this new platform. The author is currently discussing with UiB in how far Canvas could be a viable alternative to running a dedicated LMS server for Nuclear Medicine. (4) The proposed structure of the lessons is largely based on the weekly Nuclear Medicine video conferences established since 2013. As our experience with e-learning tools unfolds, the format of the lessons may be modified. The same caveat will apply if the present system of specialist training is re-organized into competency modules. (5) The present evaluation of the system is still in a preliminary stage. A more thorough investigation is planned in cooperation with Robert Gray Jr., Department of Education at UiB, when the planned course in Nuclear Medicine takes place.

### Acknowledgements

I thank Andreas Tulipan at OUH for his initiative of establishing the national webcasting platform for Nuclear Medicine, and my colleagues in the Specialty Committee for Nuclear Medicine at Dnlf and in the NFNM steering committee, in particular Katrin Weigel, for presenting me with the challenge of implementing a national imaging server. I am indebted to Assoc. Prof. Robert Gray, Jr., at

the Department of Education at UiB for helpful advice and moral support in the choice and implementation of LMS. My collaborators at HVIKT are too numerous to name, but I would like to mention Ørjan Andersen (Services and Innovation), Lars Erik Baugstø-Hartvigsen (security officer), Tommy Schmaddebeck Dahl (certification), and Ingvild Gangdal (networking). This work was partially supported by the University of Bergen, by the Department of Radiology, Haukeland University Hospital, and NFNM for the purchase of the Oasis client-server licence.

### Conflicts of interest

The author has been acting as advisor (unpaid) for Segami Corporation, Inc., in the development of the Segami Oasis client-server system.

## References

1. Hellwig D, Freudenberg LS, Mottaghy FM, Franzius C, Krause T, Garai I, Biermann M, Grüning T, Leitha T, Gotthardt M. Nuclear medicine in Europe: education. *Nuklearmedizin*. 2012;51:35–46.
2. Spesialistutdanning - Legeforeningen.no [Internet]. [cited 2014 Sep 20]. Available from: <https://legeforeningen.no/Emner/Andre-emner/Spesialistutdanning/>
3. Nukleærmedisin [Internet]. Helsedirektoratet; 2016 [cited 2016 Apr 6]. Available from: <https://helsedirektoratet.no/autorisasjon-utdanning-og-godkjenning/spesialistgodkjenning/lege/nukleermedisin>
4. Lykke KH, Handal G, Lauvås P. Veiledning med leger under utdanning [Internet]. Oslo: Gyldendal Akademisk; 2010. Available from: <http://www.gyldendal.no/Faglitteratur/Medisin/Profesjon/Veiledning-med-leger>
5. Kilminster S, Cottrell D, Grant J, Jolly B. AMEE Guide No. 27: Effective educational and clinical supervision. *Med Teach*. 2007;29:2–19.
6. Stokmo HL, Reitan BC, Johnsen B, Gulati A, Kleven-Madsen N, Adamsen TCH, Biermann M. Introduction of positron emission tomography into the Western Norwegian Health Region: Regional balance in resource utilization from 2009 to 2014. *Clin Physiol Funct Imaging*. 2015;
7. Biermann M. A simple versatile solution for collecting multidimensional clinical data based on the CakePHP web application framework. *Comput Methods Programs Biomed*. 2014;114:70–9.
8. Biermann M, Kråkenes J, Brauckhoff K, Haugland HK, Heinecke A, Akslen LA, Varhaug JE, Brauckhoff M. Post-PET ultrasound improves specificity of 18F-FDG-PET for recurrent differentiated thyroid cancer while maintaining sensitivity. *Acta Radiol*. 2015;56:1350–60.
9. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP. Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*. 2014;111:8410–5.
10. Lautrette A, Schwebel C, Gruson D, Talbot RW, Timsit J-F, Souweine B. Transfer of take-home messages in graduate ICU education. *Intensive Care Med*. 2011;37:1323–30.
11. Snyder LG, Snyder, Mark J. Teaching critical thinking and problem-solving skills. *Delta Pi Epsilon Journal*. 50:90–9.
12. Fremtidens legespesialister. En gjennomgang av legers spesialitetstruktur og innhold [Internet]. Oslo: Helsedirektoratet; 2014 Nov. Report No.: IS-2079-3. Available from: <https://helsedirektoratet.no/publikasjoner/fremtidens-legespesialister-enn-gjennomgang-av-legers-spesialitetsstruktur-og-innhold>
13. Legens spesialistutdanning. Detaljutredning av Helsedirektoratets oppgaver i ny organisatorisk modell [Internet]. Oslo: Helsedirektoratet; 2015 Aug. Report No.: IS-2356. Available from: <https://legeforeningen.no/PageFiles/222655/Rapport%20-%20Legenes%20spesialistutdanning%20-%20Detaljutredning%20av%20Hdirs%20oppgaver%20i%20ny%20modell.pdf>
14. Hviding K, Austvoll-Dahlgren A, Holde HH, Flottorp S. Simulering som opplæringsmetode i spesialistutdanning av leger - evaluering av effekt. 2009 Mar p. 114. Report No.: 4-2009.

## Appendix A: Technical implementation details

Based on their successful implementation of the IT infrastructure at the NM/PET-centre at HUH and of the MDCake research platform, Helse Vest IKT (HVIKT) was chosen as the primary IT provider.

Microsoft Lync as the web conferencing platform was suggested by the IT security officer of Helse Vest IKT. Since the infrastructure was already established, no further configuration was necessary.

Imaging database server (Oasis) and the LMS server (Moodle) server were both implemented on the same virtual host provided by HVIKT located in the demilitarized zone (DMZ) of the HVIKT network (Figure A1). The Oasis server system dictated the choice of server operating system (Microsoft Server 2012 R2) and relational database (PostgreSQL), which are both shared between Oasis and the LMS. While Oasis server runs on the Apache tomcat http/Java framework, Moodle is provided by a dedicated Apache httpd/PHP server. Following our previous system implementations, all connections to and from the server are encrypted using https [7]. So that course participants can access the LMS from their mobile devices also after regular work hours, the LMS is open to the internet under the address <https://nukit.ihelse.net/moodle>. Status updates are pushed to course participants via an external mail server (SMTP) in the ihelse.net domain. Since the Oasis server requires a client component that will only be available on selected hospital systems at the participating institutions, the server is firewalled from the Internet in order to provide an extra level of data security by using alternative https port 8443.

In case the LMS does not provide necessary functionality that is otherwise provided in Radiology Information Systems (RIS), MDCake is implemented as a second platform under the PHP framework. In order to meet more stringent IT security requirements for portals exposed to the Internet, Moodle 2.9 was fortified with a captcha on login (Google captcha 2) while MDCake was ported from CakePHP v. 1.3 to v. 2.7. The MDCake user administration was completely re-developed using the latest CakePHP 2.7 code including Google 2-factor authentication. Finally, the communication protocol for the Oasis server was changed from http to https. The resulting performance penalty when loading image data into the clients is noticeable when compared with the unencrypted production systems, but acceptable in a teaching context. Since the Oasis clients hold and process all

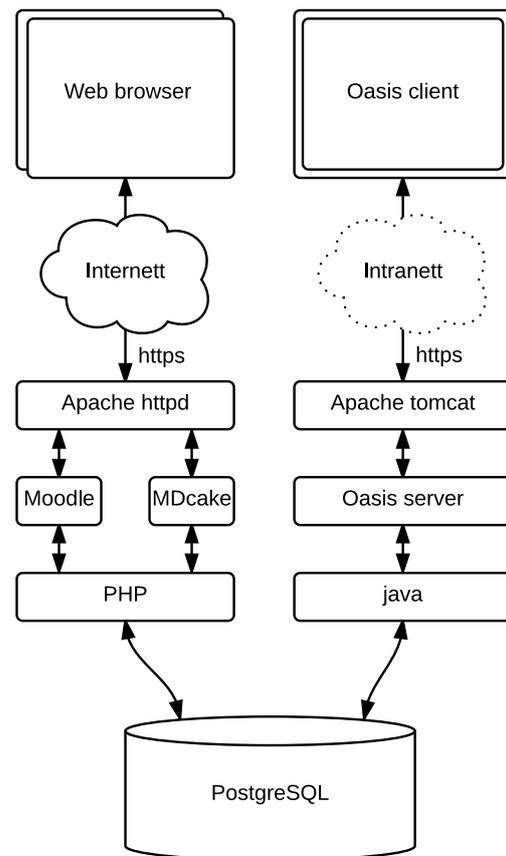


Figure A1. Network architecture of teaching server <https://nukit.ihelse.net>. The system is based on two independent web servers: (1) Apache httpd running Moodle and MDCake via a PHP framework on regular IP port 443 exposed to the Internet, and (2) Apache tomcat running the image database server (Oasis) via a Java framework on alternative https port 8443. Port 8443 is blocked from the Internet. The database management system (PostgreSQL) is shared between both servers.

image data locally on the graphics card using Open Graphics Language commands, image processing and display are equally fast on all Oasis clients regardless of the speed of the network connection to the server.