

The integration of solutions for digital assessment

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Summary

This document contains recommendation for the integration interfaces (API) of solutions for holding digital exams and for support systems, based on experience from the development work tied to integrations (Spring 2014 – fall 2015) within the national project on digital assessment for higher education in Norway.

There are plans to update the document when more experience with the integrations is available.

This document forms part of a series of documents offering recommendations on solutions for holding digital exams.

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Changelog:

Version	Date	Chapters	Change	Responsibility	Approved
0.1	17 Aug 2015	All	Structure of the BPD	MS	
0.2	01 Sep 2015	6.3	Content	SL	
0.3	02 Sep 2015	6.1	Content	AM	
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INTRODUCTION



Under the eCampus program, UNINETT has set up a project on digital assessment. The project consists of several working groups and a steering group. The present document describes the best current practice for the integration of exam solutions and associated administration systems.

Best practice documents (BPDs) have been developed to describe the recommended solutions for carrying out digital assessments in the university and college sector. The recommended solutions are based on experience from the digital-exam pilots; the discussion of laws and regulations is taken from the Norwegian report on “Digital assessment and exams – a legal assessment” [1].

The documents on digital assessment are intended as working tools for planning and facilitating the holding of digital exams. The primary target group is the technical staff and advisors responsible for planning and carrying out digital exams.

The present document does not take a position on all the existing software solutions for carrying out digital exams. It focuses on standards and principles for the integration of the implementation solution for digital exams and the surrounding support systems. Requirements concerning software, servers, virtualization solutions, firewalls and monitoring solutions follow from the chosen software solution for holding digital exams.

1 DOCUMENT STRUCTURE

1.1 The present document

The present document is in three parts

1. Schematic of the exam solution and associated systems
2. Definitions and terminology
3. Integration specifications per system

1.2 Best practice documents on digital assessment

This document

UFS 147: The Integration of Solutions for Digital Assessment

Recommendations on datasets and data exchange formats between solutions for digital assessment.

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Other best practice documents in the series on digital assessment:

UFS 145: Physical Infrastructure for Digital Assessment

Recommendations on the physical infrastructure in permanent and temporary venues used for holding digital exams.

UFS 146: Clients for Digital Assessment

Recommendations on clients used for/during the holding of digital exams.

UFS 148: ICT Architecture for Digital Assessment

Recommendations on workflow changes in the transition from paper-based to digital exams.

UFS 149: Digital Assessment – Logging and Monitoring

Recommendations on logging and monitoring in connection with digital exams.

UFS 150: Requirements Concerning the Use of Cloud Services

Recommendations concerning clarifications and agreements on the use of cloud services.

2 SCHEMATIC OF THE EXAM SOLUTION AND INTEGRATION

2.1 Integration principles

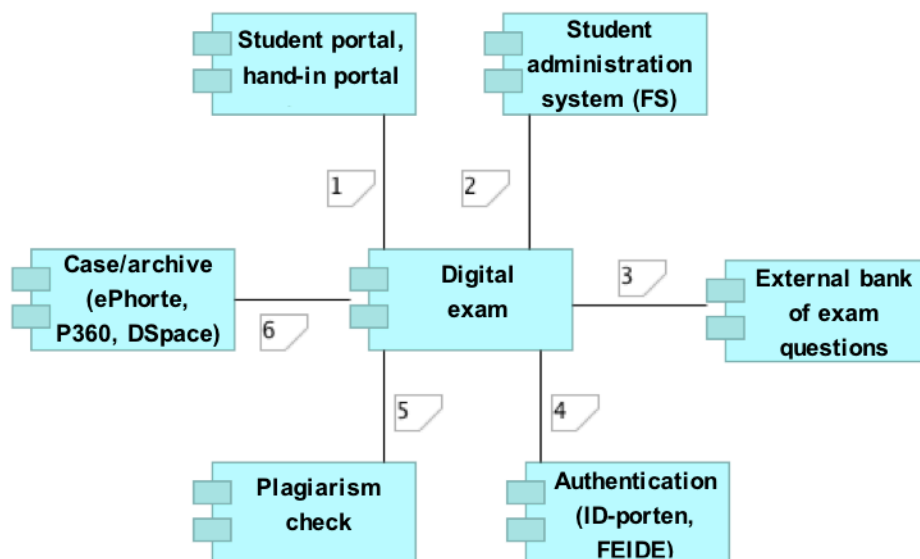
Integrations follow the architectural principles for the HE sector [2]. Of particular interest for the present document:

- Integrations shall be realized by means of open protocols and interfaces.
- Data shall be re-used and shall have a defined authoritative source.
- APIs shall be functional and should not require in-depth knowledge of the source system.

Integrations are to be realized in a cost-effective way and to make allowance for changes. Ideally, integrations are to be implemented as loose connections, to prevent strong dependencies between systems. The governing principle for integrations is to seek to utilize REST/JSON as the message-carrying technology and well-defined APIs as interfaces between the services or systems.

2.2 Integrations for digital assessment

The following figure is taken from UFS 148, and shows the interaction between the solution for carrying out digital exams and the support systems.



The interfaces to the exam solution are as follows:

1. The student portal and handing-in portal allow the examinee to submit exam papers outside the exam solution.
2. The student administration system (FS) is the authoritative source of student administration data, such as who the examinees are, the composition of grading commissions, and who the course co-ordinator is for an assessment unit.
3. The external bank of exam questions may reside with a publisher or a database of learning objects, or it could be an exam system at another institution with whom one is collaborating on the holding of exams. The exam-question archive may also serve as a bank of exam questions.
4. Authentication/login is done against external sources. Many use Feide for students, and Feide or ID-porten for examiners, but other forms of authentication may also be used.
5. To check for plagiarism, the exam paper is sent to an application that tests for text similarity and returns a text-similarity report. An assessment of the relevance of text similarity is carried out by human beings in accordance with the requirements of good citation practice.

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6. The case/archive receives everything that is to be archived or to be dealt with as administrative casework in connection with exams. Information may flow back from the administrative case-work system to the exam solution.

Details on each interface are documented in chapter 6.

The principle that existing data should be re-used entails the need to specify interfaces for the transfer of information.

One of the aims of this work has been to support the automation of processes that are currently manual. Automation requires the coordination of processes for efficiency and also poses strict requirements regarding the quality of data used at various points in the workflow. Much of the complexity in IT solutions is tied to the handling of exceptions, whether to prevent errors or where there are small variations between processes.

3 CHANGES IN THIS REVISION

This is the first version of this BPD.

FUNDAMENTALS



4 DELIMITING THE TOPIC

The focus of this BPD is on digital exams that replace traditional pen-and-paper-based written in-class exams with proctors employed in the hall. It covers exams with and without aids.

The document takes into account that various solutions are available for holding digital exams, and it therefore does not discuss details concerning software, servers or virtualization solutions.

Digital-exam client solutions intended to support oral exams or take-home exams with digital tools are not the primary focus of this BPD. Some of the specifications and tools may be used in connection with other examination forms than written digital in-class exams.

5 DEFINITIONS AND TERMINOLOGY

5.1 Personal data

Integrations inevitably entail the processing of personal data. The processing of personal data is regulated by the Personal Data Act and the associated regulation.

The report on legal assessment [1, chap. 6] (produced by representatives of UiA, UiB, UiO, UiN, HiST, UiT, the Arctic University of Norway, and NTNU) reviews the definitions and how the Personal Data Act and the regulation may be understood in connection with digital exams. In brief, personal data is defined as follows:

- Personal data includes all information and assessments that can be tied to an individual.
- Sensitive personal data is information requiring extra protection.
- Anonymized personal data is personal data from which names, personal identification numbers and other characteristics directly identifying persons have been removed
- De-identified personal data is somewhat similar to anonymized data, but there exists a key that allows finding out who the data refers to.

5.2 Exam solution

The term “exam solution” is used as a catch-all term covering all components that together form a solution for digital exams. It may be realized as one or several systems, as discussed in UFS 148, ICT Architecture for Digital Assessment [3].

6 INTEGRATION DESCRIBED PER SYSTEM

For academically-oriented processes (such as designing exam questions, writing exam papers, or grading), a high level of flexibility is important. For administrative tasks, it is important to support standardization and automation, and to interact efficiently with existing support systems.

The working group has found no open standards covering all the needs tied to integration for digital assessment. We recommend placing greater weight on the needs of academic work and in this case, the IMS standards [4] will, in our opinion, cover most of the needs. The standardization of process support should be supported in the development of a common specification and further work on a common understanding of the processes, and documentation of the REST/JSON-based web interfaces for service-to-service communication.

There is a balance to be struck between the need for specialized integration services and the expedience of having a common point of integration. What is appropriate will depend on the maturity of the API specifications, operating models, cooperative relations, security assessments, costs and complexity of information sources. The interfaces must be as simple as possible to prevent over-tight connections (which require extensive knowledge of the source system) and unwanted dependencies.

The interfaces are in the process of being tried out, and this document will be updated based on experience from the trials.

6.1 The student administration system

The student registry is the authoritative data source for administrative information tied to exams. In Norway almost all universities and colleges use FS (Norwegian: *Felles studentsystem*). The exam solutions are entirely dependent on receiving data from the FS and being able to write grading information to the FS.

6.1.1 The current solution

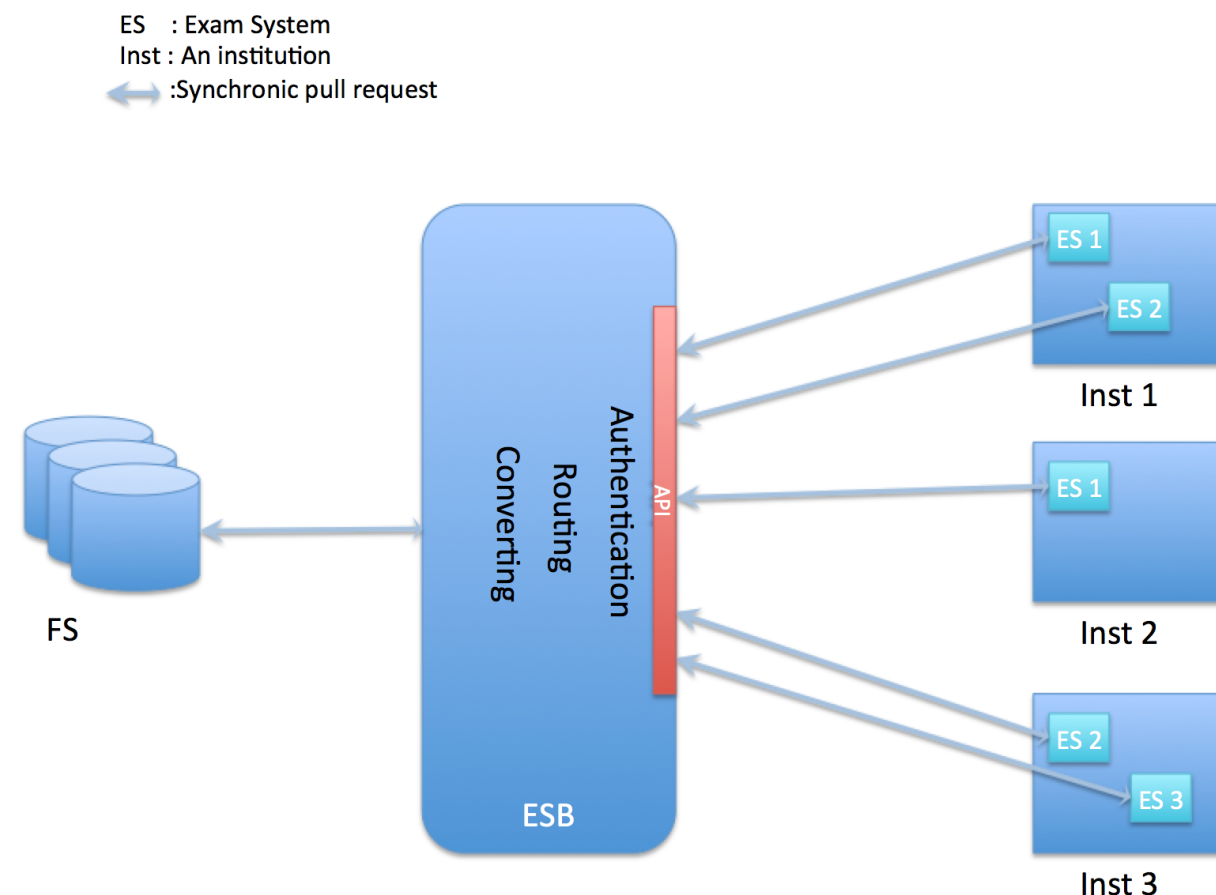
A central integration bus (ESB) has been set up; the integration with the FS passes through it. In the development phase, it has been expedient to have a single point, rather than spending resources on setting up separate bilateral integrations with many providers and FS instances.

Some elements that have been emphasised:

- Functionality has been made available without making large changes to the FS, by placing a shared API on the outside.
- Preparedness and staffing of only one critical component, instead of many (on the other hand, this will be a vulnerable component if errors arise)
- API updates can be performed in one place
- Providers can easily connect to many FS instances, which makes roll-out easier

The following picture shows the landscape for the FS in the starting phase of digital exams. At a later date, other systems (such as the FS) may be connected and accessed through a uniform API.

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A separate API has been established, and will gradually be extended with new services/calls. The API is REST-based (without HATEOAS). The data format is JSON-based and the data model is mainly based on the FS data model.

The integration with the FS provides:

- An overview of exams, with information on the exam itself
- Examinees tied to exams, with identifiers and surrounding information
- Examiners tied to exams, with identifiers and surrounding information
- Organization structure
- Attendance data for examinees tied to exams
- Results/grading for examinees tied to exams

A dynamic overview of the available calls, along with documentation and examples of the data format, is available at:

Available calls	URL	
FS production environment	https://digex.uninett.no:8086/v1/console/	Calls adopted
FS test/demo environment	https://digex.uninett.no:8086/vt1/console/	Calls undergoing assessment/development

In the pilot, the interfaces have largely been based on home-grown interfaces from the FS, but for the production phase, an implementation assessment needs to be carried out with interfaces based on existing standards. Relevant candidates from IMS Global must be reviewed to see how well they support administrative data flow for digital exams. One candidate is IMS LIS (Learning Information Services), but we

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also wish to consider REST-based alternatives such as OneRoster or alternatives adapted for higher education.

6.1.2 Interfaces

Information provided by the FS to the exam solution:

- Institution
- Course
- Assessment unit
- Commission
- Examinee
- Examiner
- Course coordinator

Information that can be received by the FS from the exam solution:

- Attendance
- Assessment
- Grading protocol

6.2 External bank of exam questions

In the work on digital assessment, it has been noted that it might be expedient to have one or more external banks of exam questions and sets of exam questions, including the possibility of viewing sets of exam questions that have been used previously. The exam solution also needs to be able to add exam questions to a bank of exam questions so that previously used questions or question sets may be made available.

So far, there has been no further work on this system, so no further work has been done on integration between an external question bank and the exam system, either. Based on descriptions, IMS Global's Question and Test Interoperability™ (QTI)[5] would be able to cover the need for integration between these systems. Further trials will show whether there is a need for adaptations beyond what is already part of the QTI standard.

6.2.1 Interface

Information the exam solution needs to be able to receive:

- Question bank
- Sets of exam questions

Information the exam solution needs to be able to send:

- Sets of exam questions, with metadata about the assessment unit
- Exam questions, with information about the set of questions to which the question belongs

6.3 Authentication

Authentication of examinees and staff is done using their Feide identity (Norwegian Federated ID for Education). The institution's Risk and Vulnerability Analysis will determine whether staff need to use the Feide functionality for strong authentication or not. Strong authentication in Feide is on security level 3, as described in the "Framework for authentication and non-repudiation in electronic communications with and within the public sector" (in Norwegian) [6]. The use of strong authentication by examinees is not recommended, as this will require access to a unit capable of receiving SMS or installing Google Authenticator-compliant software during the assessment. Further checks that the right examinee is taking the exam are performed by proctors through the existing procedures of the institution.

Integration with the Feide login service is described in "Feide Integration Guide"[7].

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The Norwegian public sector ID solution *ID-porten* [8] could be used by state owned universities and colleges as the authentication mechanism for persons lacking a Feide identity. ID-porten's authentication mechanisms comply with security level 3 or 4, depending on the method chosen by the person logging in. Integration with ID-porten is described in the documentation for Samarbeidsportalen (the cooperation portal) at the Difi (the Agency for Public Management and eGovernment). Contact Difi for access, as ID-porten is only available for the Norwegian public sector.

Assessments by the project group on digital exams suggest that alternative login solutions are not required if Feide or ID-porten are unavailable. If necessary, examinees can be given more time in the event of interruptions.

6.3.1 Interface

Information provided to the exam solution from the authentication system:

- Personal identifiers for persons (examinees, examiners, course coordinators) logging in to the exam system
- Login security level
- Feide may offer other information about the person if desired [9]

Information that the authentication system can receive from the exam solution:

- None

6.4 Student portal, hand-in portal

There have been requests for the ability to use other hand-in portals than the one provided by the exam system for handing in papers, take-home exams and similar, while still being able to use the grading parts of the exam system.

It currently remains unclear which information elements and documents are to be transferred to the exam system, but IMS Global's Common Cartridge®[10] (CC) may be a packaging format to consider. Although it was originally created for learning resources, it is capable of packaging and structuring exam papers and relevant information.

The CC standard does not define the transfer protocol between the sender and recipient, so in addition, a simple transfer method must be created, preferably a REST-based one.

6.4.1 Interface

Information provided by the system to the exam solution:

- Exam paper (answers)
- Possibly also infrastructure and client logs

Information that can be sent by the exam solution to the system:

- None

6.5 Plagiarism checks

Plagiarism checks are currently directly integrated with the exam systems being tried out. In the longer term, it must also be possible to use the plagiarism-checker functionality as a separate service through a standardized interface.

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The joint purchasing of a system for plagiarism checking/text similarity is planned for 2016, and a detailed specification of joint integration should be carried out in connection with this process.

6.5.1 Interface

Information provided to the exam solution by the system:

- Text-similarity report, with information on which textual elements are similar to what

Information that can be sent by the exam solution and received by the system:

- Exam paper (answers), with metadata on the assessment unit and possibly also the examinee number

6.6 Case/archive/storage

There have been requests for the ability to pass exam papers and surrounding information from the exam system to other systems, such as the archive, exam-paper storage and similar. Examples of such systems in Norwegian higher education includes the applications Public360, ePhorte and DSpace.

It currently remains unclear what information elements and documents are to be transferred from the exam system, but IMS Global's Common Cartridge® may be a packaging format to consider. Even though it was originally created for learning resources, it is capable of packaging and structuring exam papers and relevant information. Which information elements are included depends on the system the information will be passed to.

CC does not define the transfer protocol between the sender and recipient, so in addition, a simple transfer method must be created, preferably a REST-based one.

If possible, the interface from 6.4 Student portal, hand-in portal should be re-used.

For filing information from FS to the archive system, existing archiving capabilities will be used.

6.6.1 Interface

Information provided to the exam solution from case/archive/storage:

- None, apart from possible status information

Information that can be received by the system from the exam solution (depending on the type of recipient system):

- Set of exam questions
- Grading guidelines
- Exam paper (answers)
- Infrastructure and client logs
- Grading decision
- Report on cheating
- Case of cheating
- Assessment
- Explanation
- Explanation decision
- Case of complaint

REFERENCES



References to **relevant regulations and guidelines** that are freely available for download:

- [1] "Digital vurdering og eksamen, en juridisk vurdering" A collaboration project commissioned by the expert group on digital assessment and exams, Spring 2014, carried out by representatives of UiO, UiB, UiA, HiO, UiT, UiN, NTNU and HiST.
- [2] Felles IKT-arkitekturprinsipper for universitets- og høskolesektoren (Common ICT architecture principles for the HE sector), Heidi Bergh-Hoff (UNINETT), Carl-Fredrik Sørensen (NTNU), Jan Erik Garshol (BIBSYS), Bård Henry Moum Jakobsen (UiO), Geir Magne Vangen (FSAT), Ørjan Dypvik Pettersen (HiN) og Johnny Hansen (UiT)
https://www.uninett.no/webfm_send/1059
- [3] UFS148: ICT architecture for digital assessment, Ingrid Melve (UNINETT), Bernt Smilden (BI)
https://www.uninett.no/sites/default/files/portal_docs/CBP-44_ICT-architecture-for-digital-assessment.pdf
- [4] IMS Global, <http://www.imsglobal.org/>
- [5] IMS Question & Test Interoperability™ Specification,
<http://www.imsglobal.org/question/index.html>
- [6] Rammeverk for autentisering og uavviselighet i elektronisk kommunikasjon med og i offentlig sektor (Framework for authentication and non-repudiation in electronic communication with and within the public sector)
<http://www.regjeringen.no/nb/dokumenter/rammeverk-for-autentisering-og-uavviseli/id505958/>
- [7] Feide Integration Guide
https://www.feide.no/sites/feide.no/files/documents/Feide_integration_guide.pdf
- [8] ID-porten
<https://www.difi.no/veiledning/ikt-og-digitalisering/id-porten>
- [9] Feide's overview of available information elements for services
<https://www.feide.no/attributelist>
- [10] IMS Common Cartridge® Specification
<http://www.imsglobal.org/cc/index.html>

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UNINETT best practice documents are available from <https://www.uninett.no/ufs>

- UFS 112: Recommended Security System for Wireless Networks
- UFS 122: Recommended ICT Security Architecture in the Higher Education Sector
- UFS 127: Guide to Configuring Eduroam Using a Cisco Wireless Controller
- UFS 145: Physical Infrastructure for Digital Assessment
- UFS 146: Clients for Digital Assessment
- UFS 148: ICT Architecture for Digital Assessment
- UFS 149: Digital Assessment: Logging and Monitoring
- UFS 150: Requirements Concerning the Use of Cloud Services