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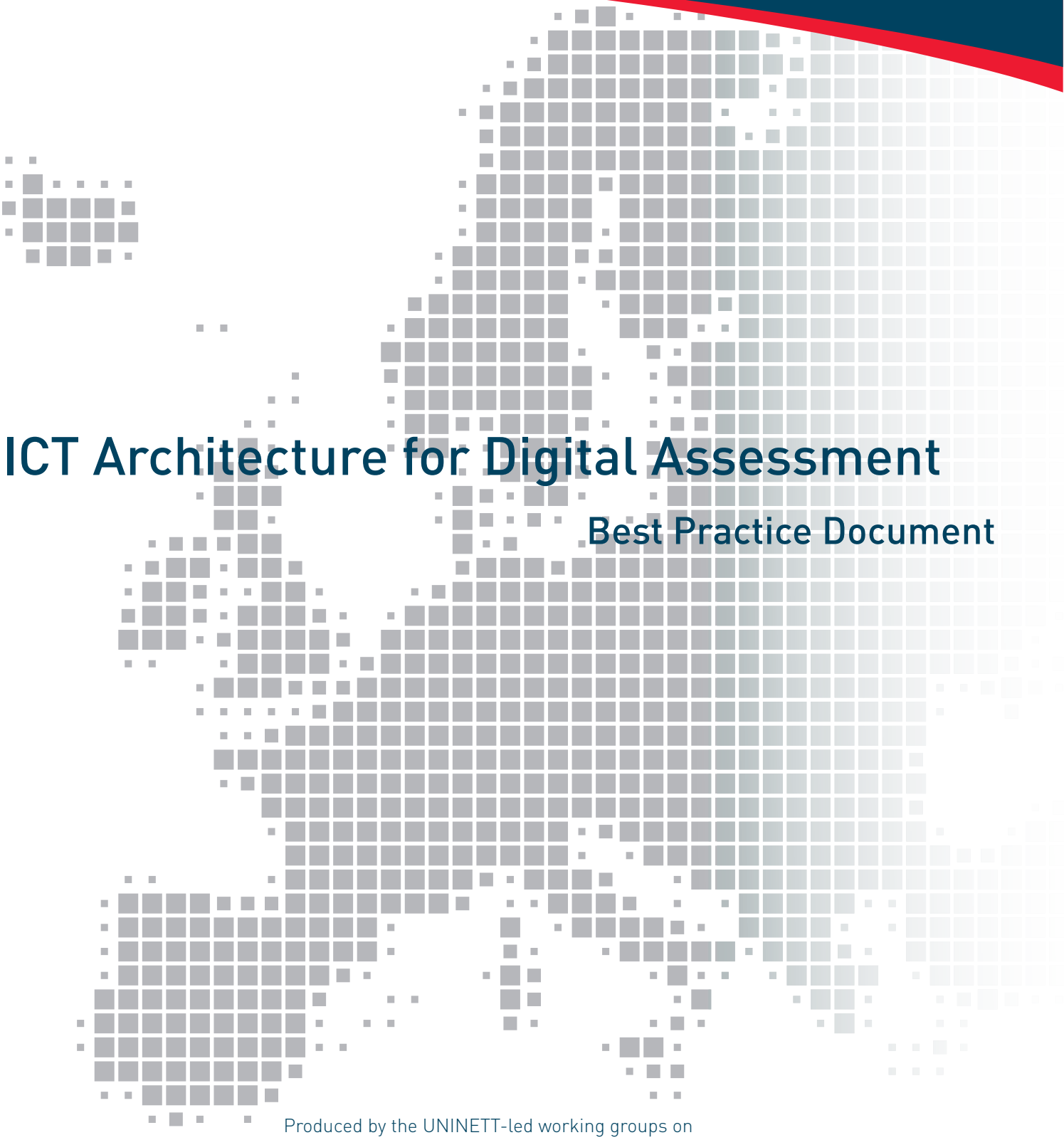

ICT Architecture for Digital Assessment

Best Practice Document

Produced by the UNINETT-led working groups on workflows in digital assessment and architecture in digital assessment

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Executive Summary

This best practice document describes a shared ICT architecture for digital examinations, with an emphasis on the requirements of digital written exams with restrictions of the use of notes or unauthorised aides. The work has been carried out by two working groups (the Digital Workflow Working Group and the ICT Architecture Working Group), composed of participants from Norwegian universities and university colleges as part of the eCampus programme. This best practice document is part of a series of reports on digital exams that also covers the requirements concerning infrastructure, client equipment and a planned integration specification [CBP].

This best practice document describes the recommended best practice for digital workflows in connection with the holding of exams (electronic management of assessment) in Norwegian higher education. Work processes for digital assessment are described alongside process charts and a table of changes from today's process to a future digitialised process in Appendix B. A well-functioning ICT architecture depends on the right level of standardisation of processes and information. This best practice document describes these conditions and forms a basis for further standardisation work on surrounding areas.

The working groups have taken as their point of departure the experience from local projects on the digitalisation of assessment processes, as well as experience with today's way of holding exams in Norwegian higher education. Experience gained from the development work undertaken with several providers of concrete solutions, and from practical use in actual exam situations, has been included in the assessments. The descriptions of the exam architecture are also based on this experience.

A reference architecture for digital exams is described through:

- Process analysis.
- Information architecture.
- Application maps.
- Services.
- Integrations.

Details on each topic are given in Appendix B.

The overall presentation provides a common description, across institutional boundaries in the HE sector, of the elements required in order to specify a digital exam solution for higher education. This offers a basis for avoiding silo thinking about IT solutions for digital exams, through shared understanding and clear descriptions.

Further work includes:

- The development of a specification for the joint procurement of digital exam solutions
- The specification, testing and implementation of integration interfaces in accordance with the guidelines provided in this document
- The identification of a process for further cooperation on issues connected with ICT architecture work for the HE sector
- A mapping of the information architecture for digital exams to a root information architecture for the HE sector.
- The use of models and analyses from the architecture and workflow analyses in the digitalisation work of each educational institution.

1 Document structure

The purpose of this document is to give an overview of the ICT architecture for digital exams, so that specifications for the procurement of exam solutions will fit with other infrastructure, application landscapes and processes in the Norwegian HE sector. This is the first time such a unified analysis has been carried out for large systems for on behalf of all Norwegian universities and university colleges.

The work is based on analyses of the policy framework surrounding exams, carried out by the expert group on digital assessment, in a sub-group on legislation and policy. The results are published in the Legal Report ("Digital vurdering og eksamen – en juridisk vurdering"), spring 2014,[1], hereafter referred to as the Legal Report.

The reference architecture presented in this document is the result of the working group on ICT architecture, and will be used, among other things, to provide guidelines for specification work for the joint acquisition of a new system or systems and by the working group on integration. This best practice document is part of a series of documents recommending solutions for holding digital exams and a point of departure for further work on ICT architectures in this sector. Therefore, this document will be updated and will only be finalised after the acquisition of a new system or systems. At that point, the best practice document will be more specific and make clearer recommendations for a joint ICT architecture for digital exams.

The document is in three parts:

- The exam best practice document, with recommendations
- Appendix A: Workflow
- Appendix B: Process model for digital exams

The best practice document discusses terms and conditions, process analysis for digitising the holding of exams, support systems that are supposed to be in place and the services and data forming part of digital exams for higher education.

The appendices include detailed information that may be used in the further work on digitising exam solutions in higher education.

2 Project participants

The work on this best practice document has been carried out in two working groups tied to the project eCampus Digital Exams: the Digital Workflow Working Group and the Architecture Working Group. Many people have contributed and several institutions have substituted participants during the process for various reasons.

2.1 Workflow Working Group

The content of Appendix A: Workflow is produced by the working group on digital workflows. The process charts describe the workflow for digital assessment.

The working group held four workshops to map and develop the process charts. Following the workshops, the process charts were sent to the reference group for comments. A general, common-process description for the university and university college sector was developed. The process charts form the basis for the work of the group on ICT architectures, and are intended as input for a specification on the acquisition of new solution(s) and system(s) for the HE sector.

Further work on the digitalisation of exams in higher education will be based on these process descriptions.

2.2 Architecture Working Group

The content of Appendix B 'Process Model for Digital Assessment', is produced by the working group on ICT architecture. The reference architecture in the document provides recommendations for a joint ICT architecture for digital exams.

The working group held four workshops to map and develop the reference architecture. Between the workshops, sketches and descriptions were sent to the working groups for comments, which were gathered before the next workshop. As part of the process, an expert group was appointed to sketch an overarching information-architecture model based on a review of the recognised international specifications and standards for the sector. This entire effort resulted in a set of target description diagrams that together form a proposal for a common future ICT architecture for digital exams in the HE sector.

The ICT architecture is intended as input for further work on a common ICT architecture in the sector, as well as for a specification for the acquisition of new solution(s) and system(s) for the university and university college sector.

2.3 Working group participants

Institution	Working/reference group, workflows	Working/reference group, architecture
UiA	Nora Clarke	
UiB	Judith Morland	Cato Kolås
NTNU	Kjersti Listhaug, Sven Erik Sivertsen	Carl Fredrik Sørensen
UiO	Ketil Mathiassen, Alexander Lorentzen	Mathias Meisfjordskar, Einar Jerpseth, Bård Henry Moum Jakobsen, Hans Kristian Fjeld, Jørgen Henrik Hovde Grønlund
UiN	Anne Ringen Pedersen	
UiT	Ingvild Stock-Jørgensen	Nils Johan Lysnes, Johnny Hansen
HiST	Kjersti Møller	
UiS	Stig Selmer-Andersen, Kjetil Dalseth	Kjetil Dalseth
HiØ	Lena Knudsen	
HiN	Frode Næsje	Ørjan Dypvik Pettersen
HiOA	Marthe Eikum Tang	Ole Lycke, Marthe Eikum Tang, Irene Lona
HiNT		Rune Elvereng
NHH	Guro Mjanger	Thor-Inge Næsset
HiL	Steinar Hov	
DMMH	Felipe Manriques	
BI		Bernt Smilden
FSAT/FS	Geir Vangen	Geir Vangen
BIBSYS	Frode Arntsen	Jan Erik Garshol

Table 2.1: Working Group participant list

Participants from UNINETT were Freddy Barstad, Heidi Bergh-Hoff, Snorre Løvås and Ingrid Melve. PwC facilitated the process.

3 Terms and conditions

3.1 Architectural principles

The seven architectural principles [2] of the Agency for Public Management and eGovernment (Difi) provides common guidelines for all ICT work in the public sector:

- Service orientation.
- Interoperability.
- Availability.
- Security.
- Openness.
- Flexibility.
- Scalability.

The work is based on the ICT architecture vision for the HE sector: «The Norwegian HE sector shall enhance value creation through the better utilisation of resources and development in the ICT area.»

”Felles IKT-arkitekturprinsipper for universitets- og høgskolesektoren”(Common ICT architecture principles for the HE sector) [3] describes the adaptation of Difi’s principles to the university and college sector, and has guided this work. General requirements, such as those for universal design or options for cloud solutions have not been repeated. Requirements specifically tied to exam solutions have been emphasised and documented.

The principles of interoperability and scalability imply that all information elements should have a globally unique ID, even in cases where they are initially only for internal use. Structural changes in the sector, nationwide course exams, learning analysis and other announced changes will be far easier to implement with a globally unique ID that simplifies putting systems or parts of systems together. The principle of organisational interoperability implies the co-ordination of processes and the organisation of exams, expressed in this best practice document in the form of standardisation requirements in Section 4.8. Semantic interoperability implies a common information model for the exchange of exam-related information.

This work builds on the fact that data often has an existing home address; for instance, the Student Registry System (Felles studentsystem, FS) keeps an overview of the students under examination in a given course. We have identified authoritative data sources and re-used existing data sources, as far as possible.

3.2 Framework conditions for holding exams

The holding of exams in higher education is subject to a number of framework conditions regulated by laws and regulations, as described in the Legal Report [1]. This work is based on the Legal Report's analyses of the framework for exams. In addition, there are local exam regulations, which now take digital exams into account to a greater or lesser degree, depending on what has been tested at the institution concerned.

Primary and secondary schools in Norway are part of a single national education system with a central national exam solution. This system is managed by the Norwegian Directorate for Education and Training, which is also ultimately responsible for primary and secondary school exams. In higher education, the academic responsibility for exams has been delegated to each university and college, where the Course Coordinator is responsible for the exam questions. For this reason, higher education needs a distributed architecture supporting local variations and academic needs. Each institution is responsible for its own exams. At the same time, students are now taking courses at different institutions and expect the same treatment everywhere, and programmes of study may be planned across institutional boundaries. The other large user group, academic staff, will often be grading for more than one institution and their work is simplified by having similar exam solutions across institutional boundaries. Higher education requires the anonymisation of examinees, implying that personally identifying information should be pseudonymised. Our work is based on analyses of a distributed system with common requirements, not necessarily a shared application that is the same for all institutions.

The exam solutions that are being tested in the HE sector are either locally operated home-grown solutions, or cloud solutions from external providers. A cloud solution will normally have the same base functionality across institutions, but may be somewhat differently configured from one institution to another. The reference architecture provides for several types of solution and has not taken any position on what specific implementation and placement should be chosen.

The main focus has been on digital, written in-class exams with restricted aids, since the local exam projects have given this the highest priority. Solutions are being actively tested and deployed at Norwegian universities and at several university colleges. The implementation phase of take-home exams has, to a large extent, been digitalised through the use of existing LMS. Further work should look at concrete integration between existing solutions and a common exam solution.

The process analyses have focused on written exams with restrictions on aids, with a side view to other forms of assessment. One aim has been to ensure a common way of holding exams for all assessment forms, with the least possible variation in supporting processes. At the same time, there must be room for variation in the forms of assessment themselves.

A large share of a digital exam solution is support for the processes governed by fixed national regulations, as documented in the Legal Report. It should be considered to what degree Norwegian processes are the same as the corresponding processes outside Norway. This will indicate how much of a boost one can get from acquiring a product with customers outside the country, or whether a digital exam solution for higher education will in fact be fairly unique to Norway.

Both the Architecture Working Group and the Workflow Working Group see a need for working on an overarching plan to clarify digital assessment forms, not just powering up existing processes. Each

institution should carry out a re-evaluation of when written in-class exams with restricted aids are suitable.

3.3 Coordination of data and services

The distribution of responsibility for exams to each individual institution implies a distributed solution with fairly extensive interaction requirements. Exams require a great deal of coordination of processes and equal treatment of students across institutions. At the same time, each course coordinator needs to be able to shape exams according to the particular character of the course.

The following table[1] shows how the requirements concerning common data sources or a common process affects the solution space and the potential for common solutions:

	Low Demand for Common Process	High Demand for Common Process
High data-coordination requirements	Coordination • Several solutions collaborating on the same dataset. • Functionally varied solutions with well-defined interfaces.	Uniformity • Common solutions. • Little variation.
Low data-coordination requirements	Diversification • Different solutions. • Scattered needs.	Replication • Identical processes. • Shared procurement requirements. • Different datasets populating a common schema (or information architecture).

Table 3.1: Impact of common data sources or a common process requirements on solution space and solution

As can be seen in the above table, systems that are to work together will either require common data sources and a common process, or place high demands on interface definitions.

There is a guideline that students should be treated equally across institutional boundaries, which implies high commonality of process requirements linked to the holding of exams. The wish for structural change increases the demands on common data sources and common processes. Common data sources facilitate mergers, splits, and shared processes across institutional boundaries. Shared processes will also need to be considered if nationwide course exams are to be held with assessment units integrated with courses at each institution.

[1] Based on ”Enterprise Architecture As Strategy: Creating a Foundation for Business Execution” by Jeanne W. Ross

The following table shows examples tied to the current testing of digital exams concerning common process and data-coordination requirements:

Area	Common Process Requirements	Data Coordination Requirements
Course administration	Strong requirements, partly statutory	Replicated on a per-institution basis in current practice
Set of exam questions	Some minimal requirements, but also variation tied to the particular character of the course	The contents of exam question sets vary widely, some re-use desired
Assessment	Strong framework requirements, practical implementation may vary	Governed by grading guidelines across individual decisions
Complaint handling	Strong requirements governed by laws and regulations	Replicated on a per-institution basis
Explanation for grades	Requirements governed by laws and regulations, some differences in practical implementation	Replicated on a per-institution basis
Use of students' own PC for exams	Relatively lose control requirements, clear restrictions	Strong requirement to work with a coordinated set of exam questions

Table 3.2: Level of common process and data coordination per area

Structural changes and study programs that cut across institutional boundaries will require more data coordination than described in Table 3.2, which deals with the current situation.

Exam solutions should support common process requirements and, as far as possible, be based on common data sources. Specifically, the reuse of data from FS may make common data sources more difficult, since the FS structure today is replicated on a per-institution basis. Course diversity creates a significant need for modules that can be integrated with common support processes.

3.4 Models and colour codes

The models developed in the analysis work use Archimate [4] and have been drawn with the aid of the free software, Archi [5]. All the models have been made available for download [6], to make it easy for local projects to carry out further work based on the common definitions and clarifications in the present work.

We used the colour pink to separate the exam solution from the support systems, and the following colour codes:

- Yellow: Process or information elements that originate in a different application and are used by the exam solution.
- Pink: Process or information elements that originate in the exam solution and are transferred to other applications.

- Grey: Process or information elements that originate outside the exam solution and are done in a separate support system.
- Light blue: Applications, specific software solutions with interfaces for talking with the rest of the world.
- Dark blue: Roles for the people involved in the examination processes.

This colour coding is also used in the figures illustrating the models in the following section.

4 Process analysis

The processes in a digital exam solution are mapped and described in Appendix A, which contains a detailed process analysis of the four main phases of holding exams.

4.1 Examination phases

Examination consists of four main phases, and Appendix A describes activities and analyses for each individual activity within the main phases:

The desired digital exam process is documented both with charts and a table providing details on which activities can be automated, changed or preserved, and which activities arise as a consequence of a transition to holding digital exams.

4.2 Applications and processes

The following figure shows an overview of the various applications that together support a digital workflow for holding exams.

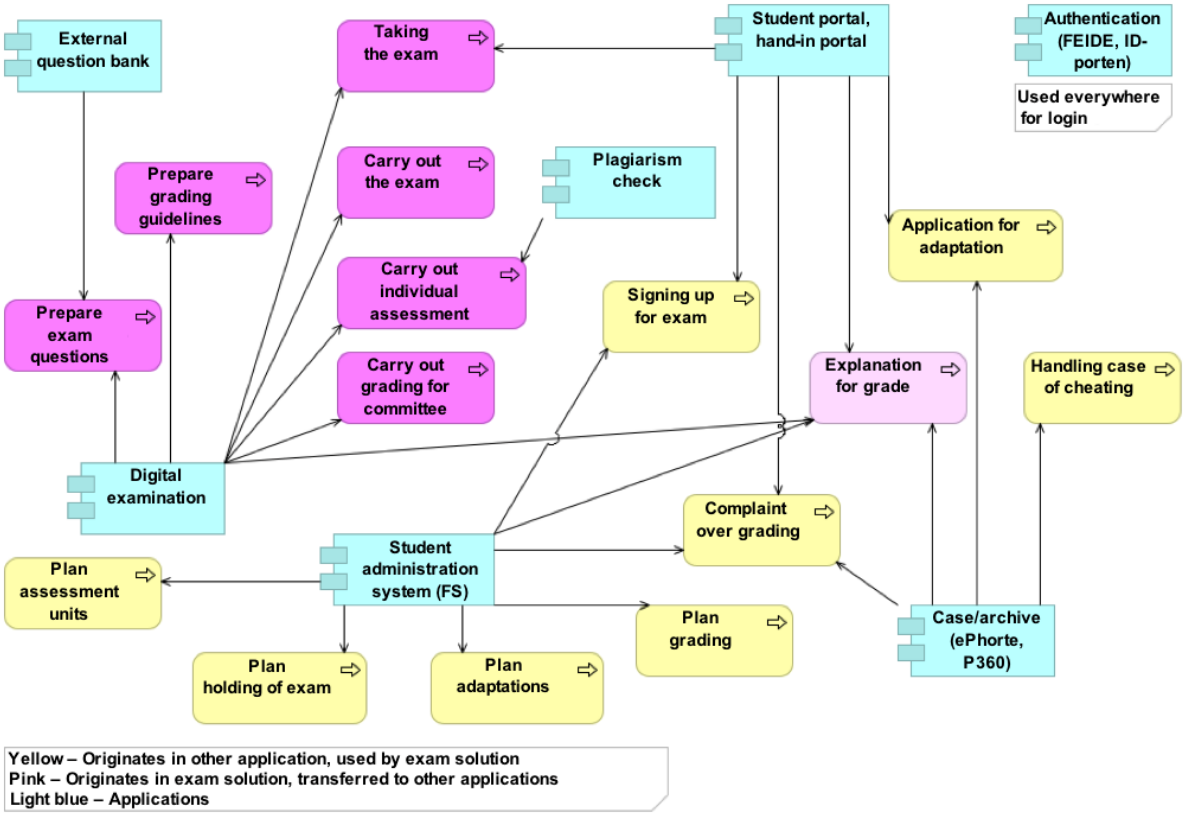

Figure 4.1: Applications overview for a digital exam workflow

Examination requires a complex set of services, and Figure 4.1 shows applications central to the different processes. The mapping of services is described in Appendix B, based on the activity analyses from Appendix A. Digital examination is composed of the processes found:

- Inside the exam solution (e.g. taking the exam and grading for committee).
- Outside the exam solution, but with data required to flow to the exam solution (e.g. in the processes “Signing up for the exam” or “ Application for adaptation”).
- Both inside and outside (Explanation for grade), where information must be gathered from the exam solution in order to implement the process, but where the process can take place on the outside. For instance, where a student is given an oral explanation based on grading information.

Details on each individual service are documented in Appendix B.

5 Information architecture

An information architecture describes the structure and relationship of the information resources. Section B2 describes the various information objects, their mutual relations and their relations to the previously defined services. It documents which services form authoritative sources and which services need to consume various information objects. Figure 5.1 shows the information elements for each phase of digital examination.

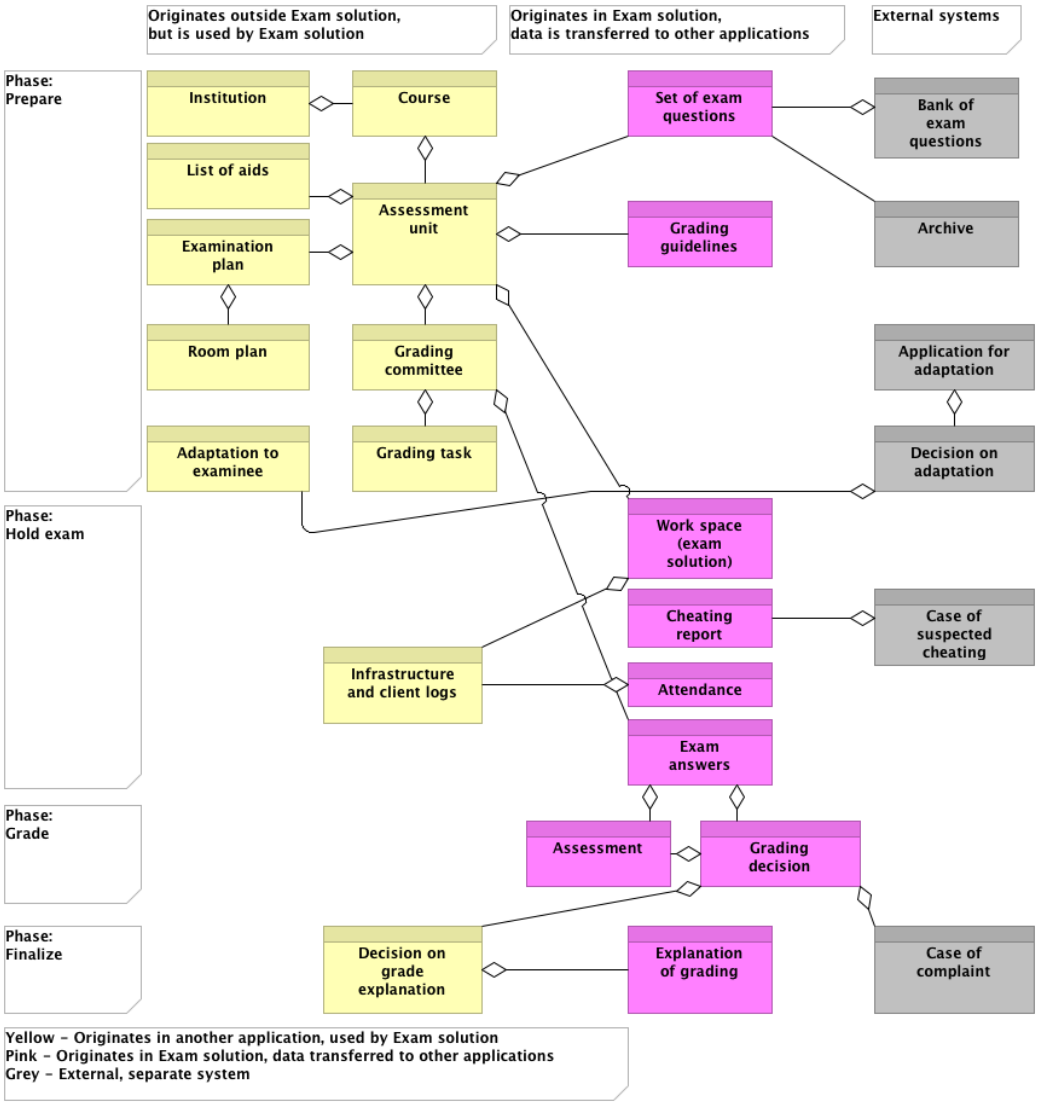

Figure 5.1: Information elements grouped by exam phase

Figure 5.1 shows the information elements identified in the analysis, distributed over the four phases of the examination processes. The assessment unit is the central information element defining the content of the exam processes. The assessment unit is defined in the course administration system and is used to anchor the other information elements in the holding of exams. We have chosen not to chart archiving, log-in and other ordinary elements that are re-used in several phases, but instead, have included descriptions of these in the detailed activity charts in Appendix B.

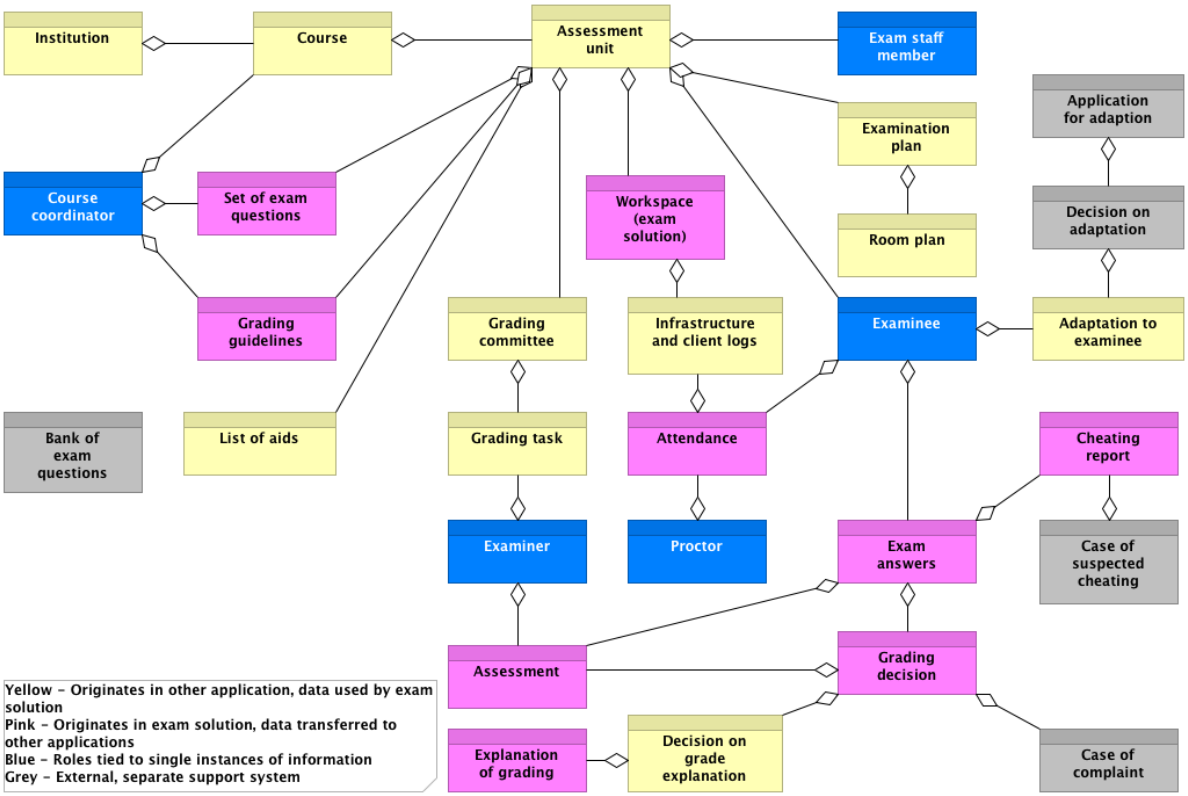

Figure 5.2: Linking roles to information elements

6 Map of applications

The following figure shows the interaction between the digital exam and the support systems:

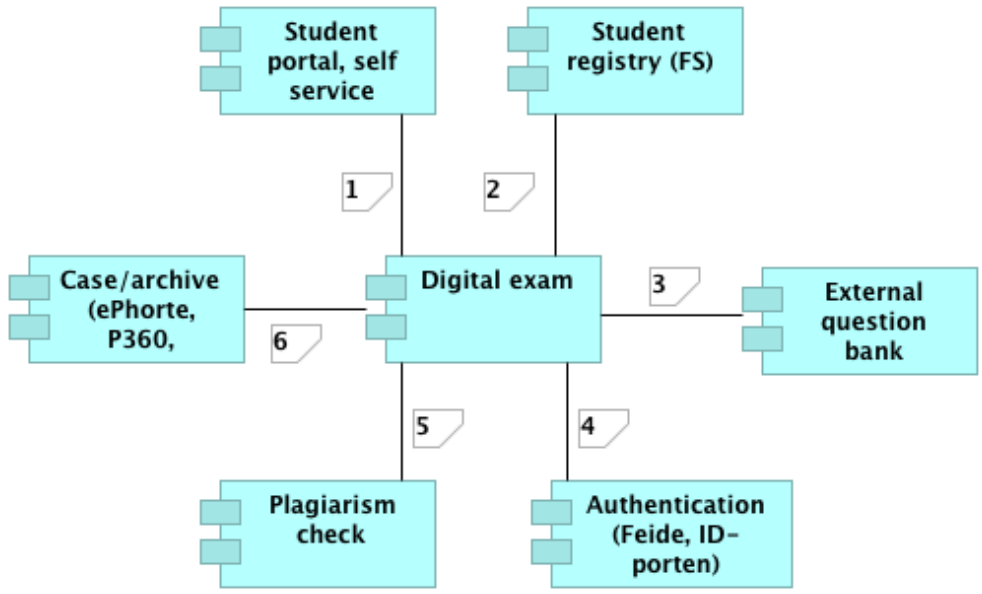

Figure 6.1: Support systems and digital exams

Details on each of the interfaces are documented in Appendix B.

7 Services

The principle that existing data is to be re-used implies the need to specify interfaces for moving information, as do the principles of service orientation, flexibility and interoperability.

One of the aims of this work has been to support the automation of today's manual processes. To be efficient, automation requires coordination of the processes, and requires high data quality in different places in the workflow. Much of the complexity of the IT solutions is within the area of exception handling, whether to prevent errors or where there are minor differences between processes. The main phases of examination are listed below in Table 7.1.

	Academic task	Process support
Prepare	Make exam-question sets with accompanying grading guidelines	Plan the holding of exams with the examination plan and adaptations, (if any)
Carry out	Work out answers in a controlled workspace for a digital exam	Support attending and handling exams as they are held (who, when, handed in, etc.)
Grade	Individual decisions with an assessment of each individual exam answer	Committee to handle grading (grade, protocol, formalities)
Finalise	Provide explanations on request Complaint grading with assessment and individual decision	Complaint handling and grading Archiving, storage and clean-up after the exam is held

Table 7.1: Main digital examination phases

In every phase, there is a clear divide between work tied to academic evaluation (sets of exam questions, working out answers, individual decision, explanation) and work tied to the housekeeping processes for holding exams. This division has been made in order to appropriately support academic evaluation, while automating administrative processes.

Where diversity is warranted, the cost of implementation increases to the point where common solutions usually do not make sense. Instead, requirements should be set for the base functionality and facilitation of standardised interfaces so that modules can be easily integrated. For example, when developing exam questions, it will be important to integrate new questions with the existing question bank and workspace modules. The question bank module could be used to develop the question set. The workspace module could be used both by the course coordinator for question formulation (for

example for using formulas, math support, simulations and special software) and by the students for working out the answer in accordance with the academic requirements.

Details on services and functionality are documented in Appendix B.

8 Integrations

Based on this document, a separate digital exam integration working group will carry out further investigation into digital assessment. The overall guidelines for their work have also been documented (for details, see the integration specification to be published in the Campus Best Practice series on digital exams).

8.1 Choice of standards: IMS

The working groups have not found any open standards that cover all the needs associated with digital exam integration. We recommend placing the greatest weight on those needs that are tied to academic work, as described in Section 3.3; then, the IMS standards [7] will, in our view, provide the best starting point for further work, even if the current standards do not include everything needed. Standardisation of process support should be aided by the development of an over-arching specification and further work on a common understanding of the processes.

8.2 Interface for integration

In connection with testing solutions, a joint integration point has been established between FS and digital exam solutions. Further work should be undertaken on the specification, practical use and testing of more exam solutions and exam interfaces.

The output from the digital exam integration working group should present a recommendation on the utility of common integration components beyond the testing period and how governance and operations should be performed if common integration components are recommended.

8.3 The diversification of learning content increases standardisation requirements

The course coordinator has considerable latitude in shaping the exam, and there are great variations in the content of exam questions. Exam questions must meet minimum process requirements, such as allotted time for answering and relevance to the course curriculum. However, there are fewer process requirements pertaining to questions than for other parts of the exam processes, which suggests the need for a broad set of solutions. Standards are necessary for solutions to be able to

interact with a central examination system, and for the integration of exam question sets. These needs also justify distinguishing between academic and process requirements, so that different modules for the academic work can be used with a common exam solution for process support. Corresponding requirements also apply to the other academic tasks, as discussed in Section 7.

9 Further work

The specification for the joint procurement of a digital exam solution will be based on the reference architecture documented here, as well as the other best practice documents on digital exams. A requirements analysis should be performed in light of international practice in this field to see what form future exam solutions should take.

Further work is required when it comes to the detailed specification of the integration interfaces described in Section 8. A digital exam integration working group under the auspices of the eCampus project on digital exams is to specify interfaces and publish an integration specification, based on practical experience from local projects and the work presented this document.

A number of overarching issues outside the mandate of the working group have come up in discussions. There is a need for clear ownership / process for dealing with any ICT architecture issues (such as setting up an HE architecture council). In order to profit from common ICT solutions, either data or processes need to be coordinated. The lack of a common anchor point for these discussions makes it more challenging to work out a shared understanding. It was not part of the working groups' mandate to discuss overarching issues involving systems outside the exam solutions, such as:

- Is the current use of FS with the replication of datasets optimal in a holistic perspective, given the announced structural changes and the increased use of web-based learning?
- Is there a need to introduce support for surrounding processes in FS, in order to simplify the integration with a digital exam solution?
- How extensive is the need for the standardisation of exam-related processes across institutional boundaries?
- Should a submission portal for all assessment forms be integrated with the existing LMS solutions?
- Document best practices for the registration of information on examiners.
- Establish an agreed notion of 'student' and clarify how personal information is managed and re-used in cross-cutting ways
- Clarify how extensive the need is for written digital exams with restricted support materials, given the cost and the option of alternative digital assessment forms.
- Evaluate the possibilities of a digital tool for improving the assessment processes.

Digital assessment is a large topic, and work will need to consider various digital assessment forms and to assess integration needs between summative and formative assessment. This document only discusses processes tied to the classical exam, which is a summative assessment. The working group has not yet considered a submission portal for formative assessment forms as priority was given to digital exams. The reference architecture detailed in Appendix B is designed so that parts can be re-

used as a base for an exam hand-in portal. The interaction between the assessment processes and the other parts of a teaching course (coursework assignments, etc.) has also been considered out of scope for this project. There is a need for further analyses of the interaction between a handing-in portal and grading possibilities in a digital exam solution.

This best practice document, with information in Appendix A on workflow and Appendix B on architecture, will be of most use if further discussion and work is done with a shared understanding of ICT architecture in the HE sector. Profiting from common ICT solutions requires either the coordination of data or processes, or doing work on the specification of interfaces.

Local projects that are to specify exam-related solutions can use the reference architecture as a point of departure for their work. Models, charts and this document are published for open access, and their re-use is welcomed.

Appendix A Work Processes for Digital Assessment

Author: Working group for digital work processes for digital assessment (eCampus digital eksamen, arbeidsgruppe for digitale arbeidsprosesser)

Date: 23.01.2015 https://www.uninett.no/digitaleksamen

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Executive Summary

This appendix contains descriptions of work processes for digital assessment, described with process charts and a table of changes between the present process and a future digitalised process. The working group has taken experience from local projects on the digitalisation of assessment processes as a point of departure, along with current exam experience in higher education.

The work processes have been divided into three different models, based on the approach of the working group on digital workflows in the project on digital exams:

1. **Present process**

   Shows a summary of the current workflow for exams at various university colleges and universities.

2. **Transformation from the present process to the future process**

   Describes the changes needed in the present process in order to achieve the future process.

3. **Future process**

   Describes the desired way of working in the future.

This document is a first draft summing up the work performed in the working group on digital workflows in the autumn of 2014. The process charts will be used and further developed by other working groups and may be expanded on further in the specification work on a new system or systems. The main target group of the present version of the document are the colleges and universities that participate in the national project on digital exams, the providers who take part in the development process, and the working groups in the project.

This working memo will be updated after the acquisition of the system(s) and after more work has been done on understanding the needs and options for solutions. At that point, a more concrete best practice document with clearer recommendations for the work process for digital assessment can be developed. An updated version of this document can then be included in the document series recommending solutions for holding digital exams.

Part I: Introduction

UNINETT has set up a project on digital exams under the auspices of the eCampus program. The project consists of several working groups and a steering group. The content of this document was produced by the working group on digital workflows, and the process charts describe the workflow for digital assessment.

The working group held four workshops to map and develop the process charts. After the workshops, the process charts were sent to the reference group for comments. A general, common process was developed for the university and university-college sector. The process charts form the basis for the work of the group on ICT architecture and are intended as input for a specification for the acquisition of new solution(s) and system(s) for the HE sector.

Further work on the digitalisation of exams in higher education will be based on these process descriptions.

A.1 Document structure

The document is in three parts:

- **Part I: Present process**

  Describes the current situation for carrying out assessment. The process charts are a visual and concise presentation of the workflow.
- **Part II: Transformation from the present process to the future process**

  The process charts are colour-coded and offer descriptions of the changes that should be made to today's process in order to derive the future process.

  The table gives the same information as the process charts, but also includes some comments and allows sorting. It may also be used in further work to include more details.
- **Part III: Desired process**

  Describes the future desired work process for carrying out digital assessment.

  The main content of this document is process charts for holding exams.

A.2 Terms and principles

Before the workshops, the following terms were drawn up for the work process:

- Starting point for the process: "Employee sets up an assessment unit in FS" [Felles studentsystem; Common Student System]. The assessment unit in FS may be seen as the hub of the exam process, and consists of several generic information objects that govern the exam process.
- Endpoint for the process: "The examinee has received a final grade in Studentweb (the deadline for complaints has expired, any complaint handling has been concluded and the complaint case has been archived)".
- The exam questions consist of a set of questions in several parts.
- What we need to map are the various partial assessments. (Exams in a course may consist of various combinations of assessments.)

- We need to map the most traditional assessment arrangements as they stand today. Future forms of assessment do not form part of this mapping.
- We shall take obligatory working requirements into account (conditions for taking the exam).
- We can identify divergences or differences between the institutions, but we are to chart a common process. Any divergences need to be described.
- We need to map what activities are carried out by the various roles, regardless of their place in the organisation.
- In-class exams are the point of departure for the process, but the idea is that the process can be adapted to other assessment arrangements, such as portfolio assessment and take-home exams.

The working group has taken as its point of departure the experience from local projects and the work done in the expert group on digital assessment, including the report on legal issues connected to digital assessment from June 2014. We place emphasis on written-in-class exams, even though the processes are often the same for other examination forms.

The work process was divided into four main phases:

- Preparation.
- Carrying out.
- Grading.
- Finalising (complaint processes, storage, archiving).

A.3 Definitions

A.3.1 Explanation of roles

Examinee: The person (candidate) taking the exam (student, external candidate or other).

Exam staffer: An administrative employee with administrative activities tied to exams at the institution.

Course coordinator: The person who carries out academic activities tied to exams (developing exam questions, grading guidelines; typically the course lecturer employed at the institution).

Examiner: The person assessing the examinee's performance. May be internal or external.

Proctor: A person physically present at exams while they are held to ensure that they are carried out in accordance with the regulations.

IT manager: ICT support for the entire work process around the exams. Includes operation, user support, technical monitoring and handling of security for ICT.

A.4 The four main phases of the process

The workflow for digital exams was grouped into the following four main phases:

1. Preparation

In the preparation phase, the framework conditions for carrying out the exams are set. The preparation phase extends from the starting point of the process, the setting up of an assessment unit in FS, until the time the actual exam is held. In this phase, the examinee signs up for the exam, the roles tied to the holding of exams are defined (examiners, examinees, committees, proctors), and the exam questions are developed. In addition, the time and place the exam is to be held must be set, and any adaptation measures planned.

2. Carrying out

The carrying-out phase takes place on the day of the exam and involves handing out the exam questions, working out answers and handing in the answer paper.

3. Grading

The grading phase comes after the carrying-out phase and involves examiners given access to the exam answer papers for the purpose of assessment. This sub-process is carried out, both in connection with ordinary grading and when a complaint is made about a grading decision.

4. Finalising (processing the explanation and complaints, storing, archiving)

The last phase involves allowing the student to access the result and, as needed, to request an explanation and file a complaint about the grade. In case of a complaint, a new grading iteration takes place. In addition, this phase includes paying examiners and proctors, as well as archiving the exam questions and the storage of answer papers in accordance with the applicable regulations.

Process charts have been developed for each of the four phases, as described in the following sections.

A.5 Project participants

The working group that has worked on the process charts and participated in the workshops included the following participants:

- Anne R. Pedersen (UiN).
- Lena Knudsen (HiOF).
- Sven Erik Sivertsen (NTNU).
- Ketil Mathiassen (UiO).
- Kjersti Møller (HiST).
- Frode Næsje (HiN).
- Geir Vangen (FS).

- Aleksander Lorentzen (UiO).
- Kjersti Listhaug (NTNU).
- Freddy Barstad (eCampus, UNINETT).

The reference group that has contributed input to the work processes included the following participants:

- Nora Clarke (UiA).
- Judith Morland (UiB).
- Ingvild Stock-Jørgensen (UiT).
- Stig Selmer-Andersen (UiS).
- Marthe Eikum Tang (HiOA).
- Guro Mjanger (NHH).
- Steinar Hov (HiL).
- Felipe Manriques (DMMH).
- Frode Arntsen (BIBSYS).
- Kjetil Dalseth (UiS).

PricewaterhouseCoopers (PwC) has assisted by facilitating and documenting the work. UNINETT has been the secretariat for this document.

Part II: The present process

A.6 The present process

This section sums up how different university colleges and universities carry out exams today. The process charts give a rough overview of the workflow, but do not enter into details of the individual processes. Complex processes must be further detailed in a specification phase. In general, many activities in the present processes are manual.

The individual activities, such as appointing the examiner, are carried out at different times by the different institutions. The working group concluded that the sequence of individual activities is not decisive for further work on processes in the ICT architecture group, and that they, therefore, did not require specification in the general process chart. What matters is that all the processes are represented and tied to the correct role. The focus, therefore, has not been on describing the differences between the sequences of activities between the institutions, but rather on presenting an overall, general process supported by all the institutions represented in the working group.

The whole process describing the workflow in a digital assessment was grouped into four main phases. The four main phases are shown in Figure A1 and presented in greater detail on the following pages.

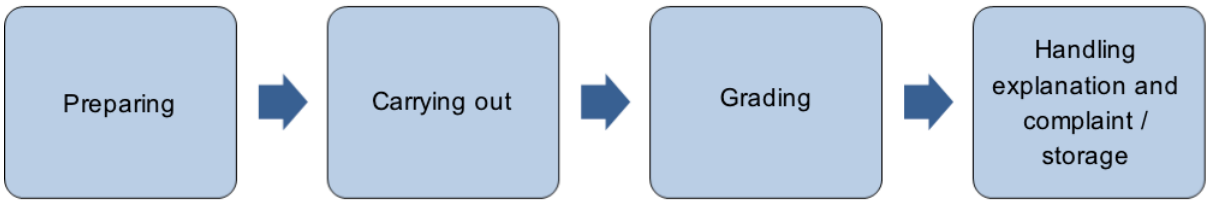


Figure A.1: The four main phases

A.6.1 Preparing the exam

As shown by the process chart in Section A7.1, the preparation phase consists of many manual and paper-based activities. Generally, many of these activities reside with the exam staffer and course coordinator.

The exam staffer prepares the administrative aspects of the exam, with activities such as:

- Setting up an assessment unit in FS and drawing up the examination plan.
- Registering the appointed examiners and exam information.

- Signing up students who don’t do it themselves.
- Administratively handling and planning the facilitation of exams.
- Having the exam questions printed and distributing them on the day of the exam.
- Finding suitable halls.
- Checking the infrastructure

The course coordinator prepares the academic aspects of the exam, with activities such as:

- Proposing examiners.
- Developing sets of exam questions.
- Checking formalities concerning exam questions.
- Drawing up grading guidelines.
- Sending a list of examinees to the exam staffer.

The student prepares for the exam by:

- Signing up for the exam within the set deadlines.
- Withdrawing from the exam, as may be, within the set deadlines.
- Familiarising himself- or herself with the exam solution.

Also see the process chart in Section A.7.1 for a visual presentation of today’s preparation phase.

A.6.2 Carrying out the exam

In the carrying-out phase, most of the activities reside with the proctor. Some reside with the student taking the exam.

Activities of the proctor:

- Registering the student’s attendance.
- Checking the students’ identities.
- Checking aids, if any, and enforcing the regulations.
- Handing out exam questions.
- Updating records: who have handed in answer papers, withdrawn, or failed to show up.
- Collecting and checking answer papers.
- Delivering the set of answer papers to a central collection point.

Many of these activities are manual and paper-based in today’s process.

The student:

- Working out answers.
- May choose to withdraw from the exam as it is being carried out.
- Handing in the answer paper.

These activities, too, are manual and paper-based in today's process.

Also see the process chart in Section A.7.2 for a visual presentation of today's carrying-out phase.

A.6.3 Grading papers

In this phase, the exam staffer distributes the answer papers to the examiners along with a grading protocol and grading guidelines.

Each individual examiner:

- Checking for plagiarism, as appropriate, depending on the institution's procedures.
- Grading the paper.
- Communicating with other examiners, as appropriate.
- Verifying and entering the grade.
- Signing the grading protocol.

Exam staffer:

- Sending the grading protocol to the examination office and recording the grade in FS.
- Keeping statistics.
- Publishing the results on Studentweb.

In today's process, the grading itself is a manual process carried out on paper. The answer papers and the grading protocols are sent between the exam staffer and the examiner.

Also, see the process chart in Section A.7.3 for a visual presentation of today's grading phase.

A.6.4 Finalising the exam (handling explanations and complaints concerning grading decision, storing, archiving)

In the final phase, the student gets access to the result. The student can ask for an explanation of the grading decision concerning his or her answer paper within a set deadline. The student can also file a complaint over the grading decision within a set deadline. A student can initiate a direct complaint without first requesting an explanation.

In an explanation case:

- The exam staffer receives a request for an explanation and files it in the archive system.
- The examiner gives the explanation to the student, orally or in writing.
- The exam staffer files the case as closed in the archive system.

In case of a complaint, the exam staffer will:

- Receive the complaint and file it in the archive system.
- Set up a new committee.

- Send the answer paper and the grading protocol to the complaint examiners.

Grading reflects the activities described in the grading phase. Finally, the new result is recorded in FS.

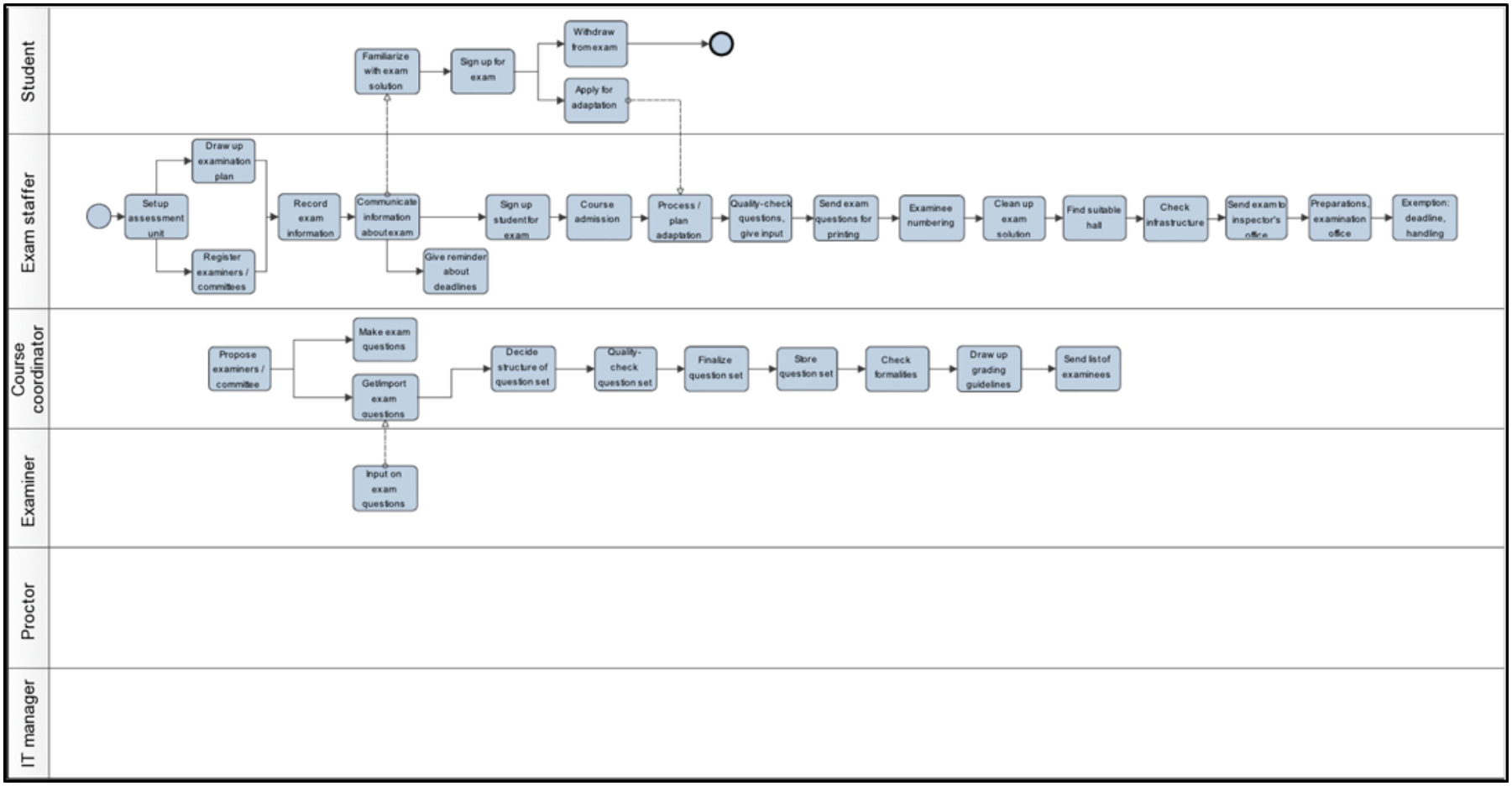
Other administrative activities residing with the exam staffer in the finalising phase include paying examiners and proctors, storing exam-related materials, and filing exam questions, as well as ensuring that answer papers are filed according to the applicable regulations. See the Legal Report for a description of the regulations tied to these processes.

Also see the process chart in Section A.7.4 for a visual presentation of today's process for handling explanations and complaints, as well as storage.

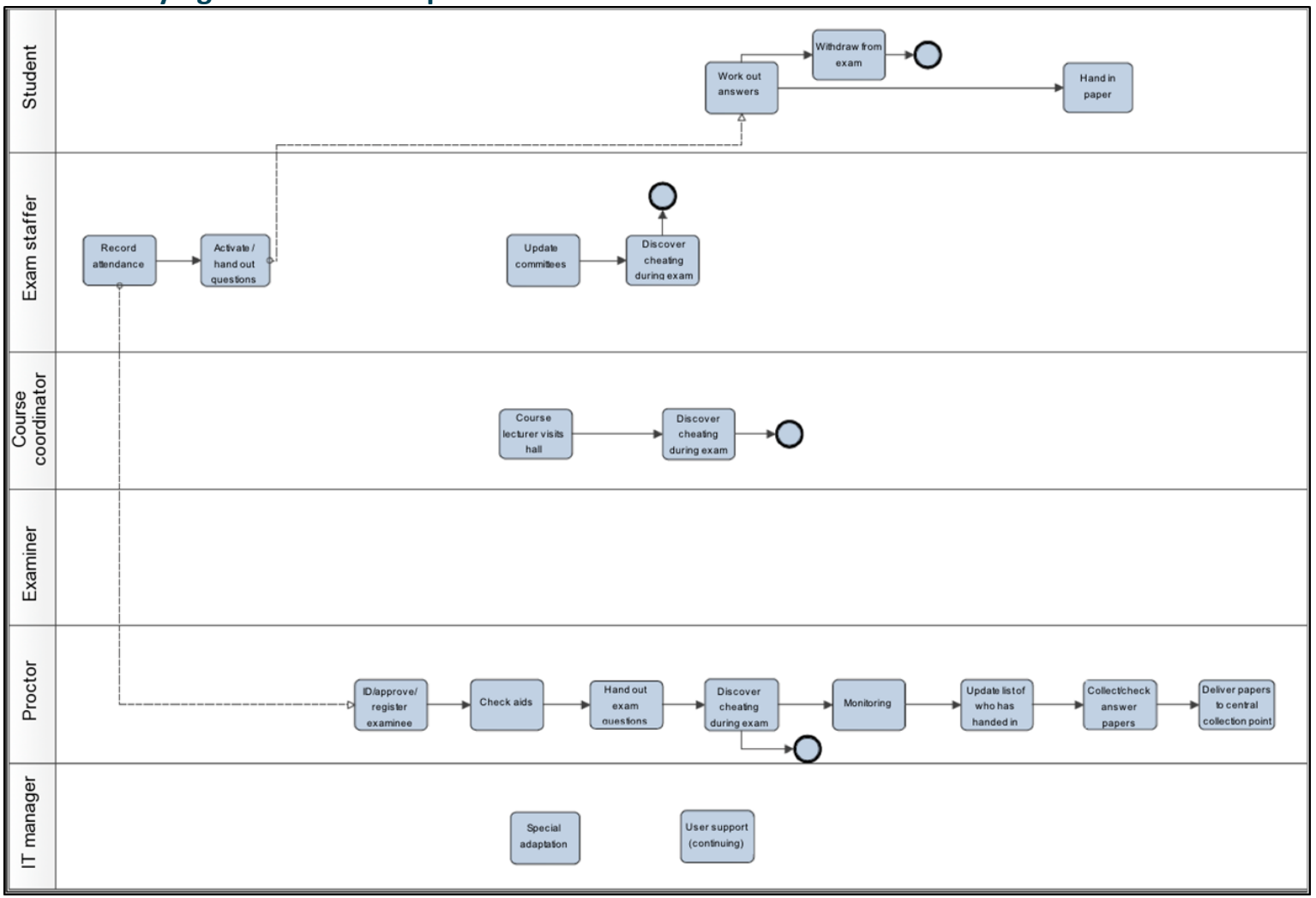
A.7 Process chart for the present process

The following process charts document the present practice of holding exams in higher education in Norway.

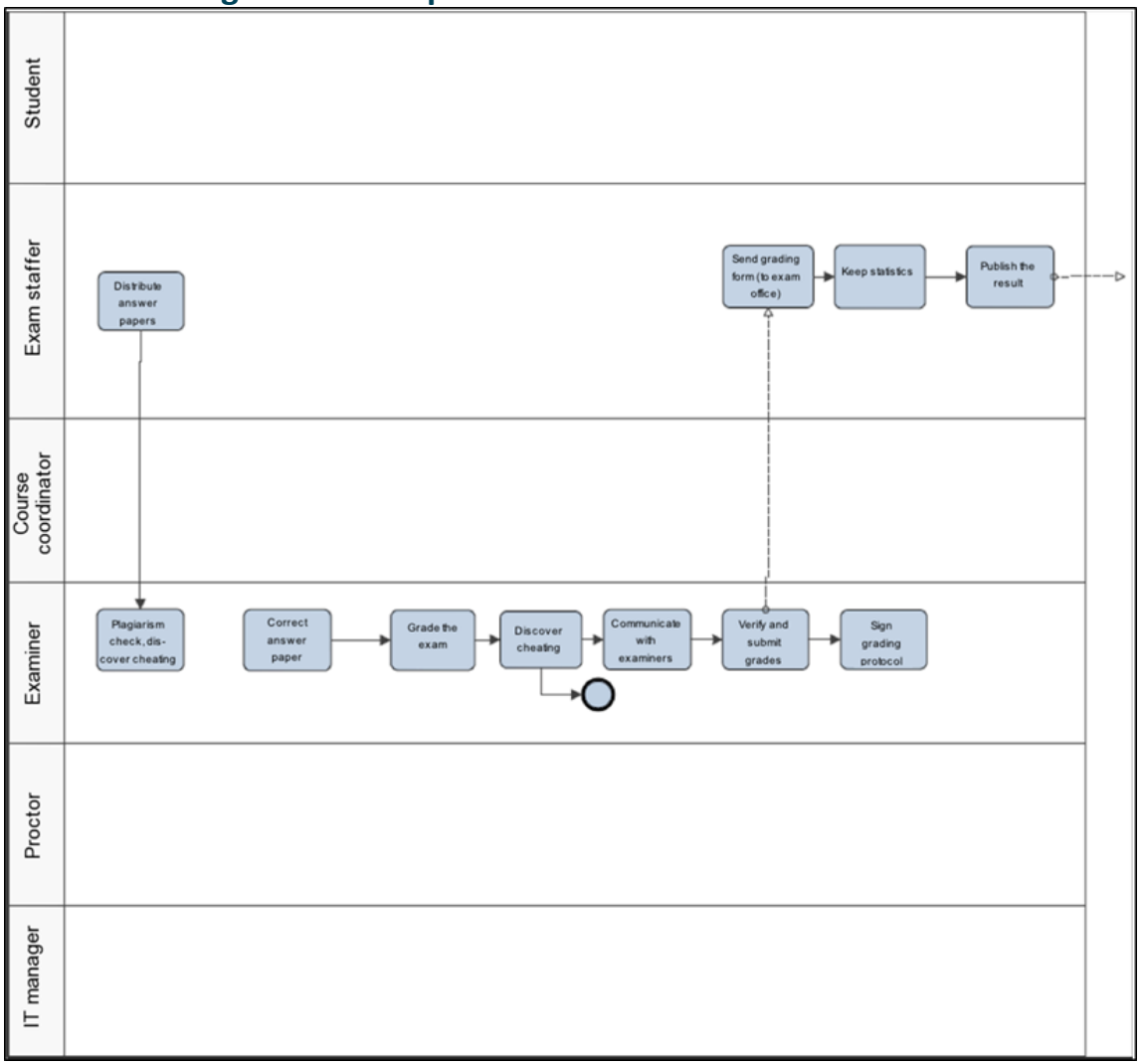
A.7.1 Preparing the exam – process chart



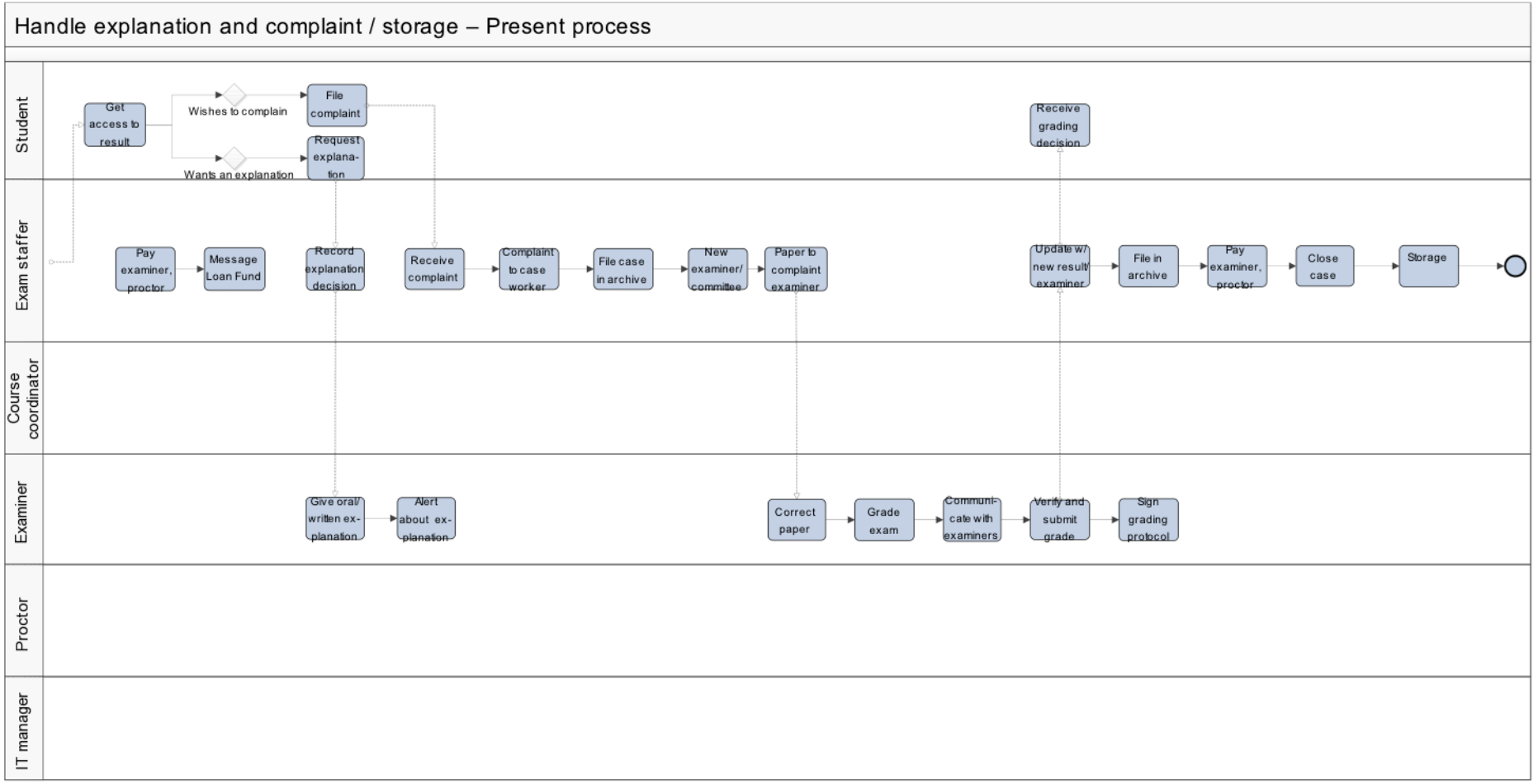
A.7.2 Carrying out the exam – process chart



A.7.3 Grading the exam – process chart



A.7.4 Finalising the exam – process chart



Part III: Transformation from the present process to the future process

A.8 Transformation from the present process to the future process

In the transformation from the present to the future process, a number of activities will be digitalised or wholly automated. Some activities, such as manually signing a grading protocol and sending sets of exam questions for printing, will no longer form part of the process and are removed. As part of the workshops, we looked at improvements to the workflow, and some activities have been simplified as a result. Some activities, such as logging in, equipment checks and logging, are required for holding digital exams and have been added as a consequence of the digitalisation of the process. A number of activities have been kept as they were, either because they need to be done manually or because they are already being carried out with digital aids. The activities in the process chart have been colour-coded to identify what has been changed in the present process in order to achieve the future process. The colour codes are as follows:

As Present (e.g. unchanged)	Changed (e.g. digitalised)	Omitted (e.g. automated)	New Activity

In general, a number of the future administrative duties of the exam staffer, the course coordinator and the examiner are automated with improved system support. In addition, many activities tied to working out and grading the exam answers, which is currently done on paper, will be carried out digitally in the future.

The changes from present process to future process are presented visually in the following pages. The process is grouped in the same way as the present process, with the four main phases as shown in Figure A2.

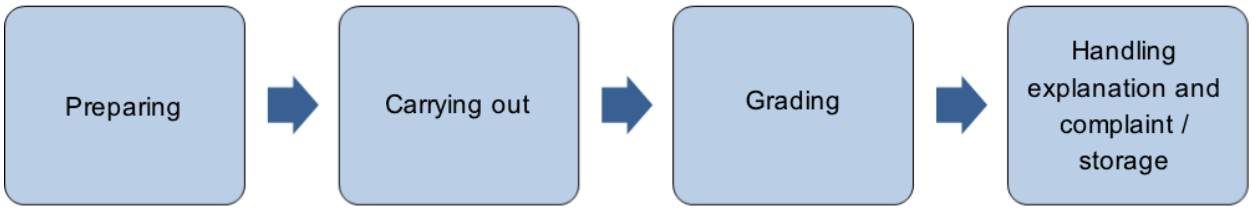


Figure A.2: The four main phases

A.8.1 Preparing the exam

Some of the steps of the present process that have not been changed are coloured green. This is because some of these activities already have system support and are being carried out digitally. These activities include:

- Setting up the assessment unit.
- Drawing up the examination plan.
- Registering appointed examiners and exam information.
- Signing up for the exam.
- Withdrawing from the exam.

Some of the activities residing with the exam staffer are removed, as these are manual processes that will be superfluous in a future digital process (coloured red in the charts below), such as:

- Sending sets of exam questions for printing.
- Finding a suitable hall (this should be done automatically in the new system, based on the number of signed-up examinees, the examination form, etc.)
- Sending the answer papers to the exam office.

Most of the activities that reside with the course coordinator, which were manual activities carried out on paper, have been coloured yellow and should be digitalised in a future process. Examples include:

- Writing exam questions.
- Getting (importing) exam questions.
- Deciding the structure of the exam questions.
- Quality assurance of the exam questions.
- Finalising the exam questions.
- Checking formalities.
- Drawing up grading guidelines.

In addition, there are two new activities for the IT manager:

- Logging and preparing surveillance of how the exam is carried out
- User support

These are activities that will be in greater demand with a digital exam, so the working group has chosen to highlight them in the future process.

Also see Section A.9.1 for a visual presentation of the transformation of the preparation phase.

A.8.2 Carrying out the exam

The carrying-out phase has many yellow and red boxes, indicating a strong potential for process digitalisation and automation.

A number of manual activities in the present process are coloured red and are omitted from the future process, as they are no longer needed. These include:

- Handing out exam questions.
- Collecting answer papers.
- Sending answer papers.

Furthermore, the process of the student working out the answer paper is digitalised, in that the writing of the answer paper can be done on a PC.

Some new processes are required for carrying out exams digitally:

- Login to the system.
- Receipt for and copy of the student's answer paper.

Also see Section A.9.2 for a visual presentation of the transformation of the carrying-out phase.

A.8.3 Grading papers

The grading phase, too, has many yellow and red boxes. The grading itself will be digitally supported in a future process and the manual distribution of answer papers is omitted, as this activity is no longer needed. In the future process, the examiner should also not be required to manually sign the grading protocol, since this will be done either upon system login or through a digital signature. The process of recording grading decisions should also be digitalised.

Also see Section A.9.3 for a visual presentation of the transformation of the grading phase.

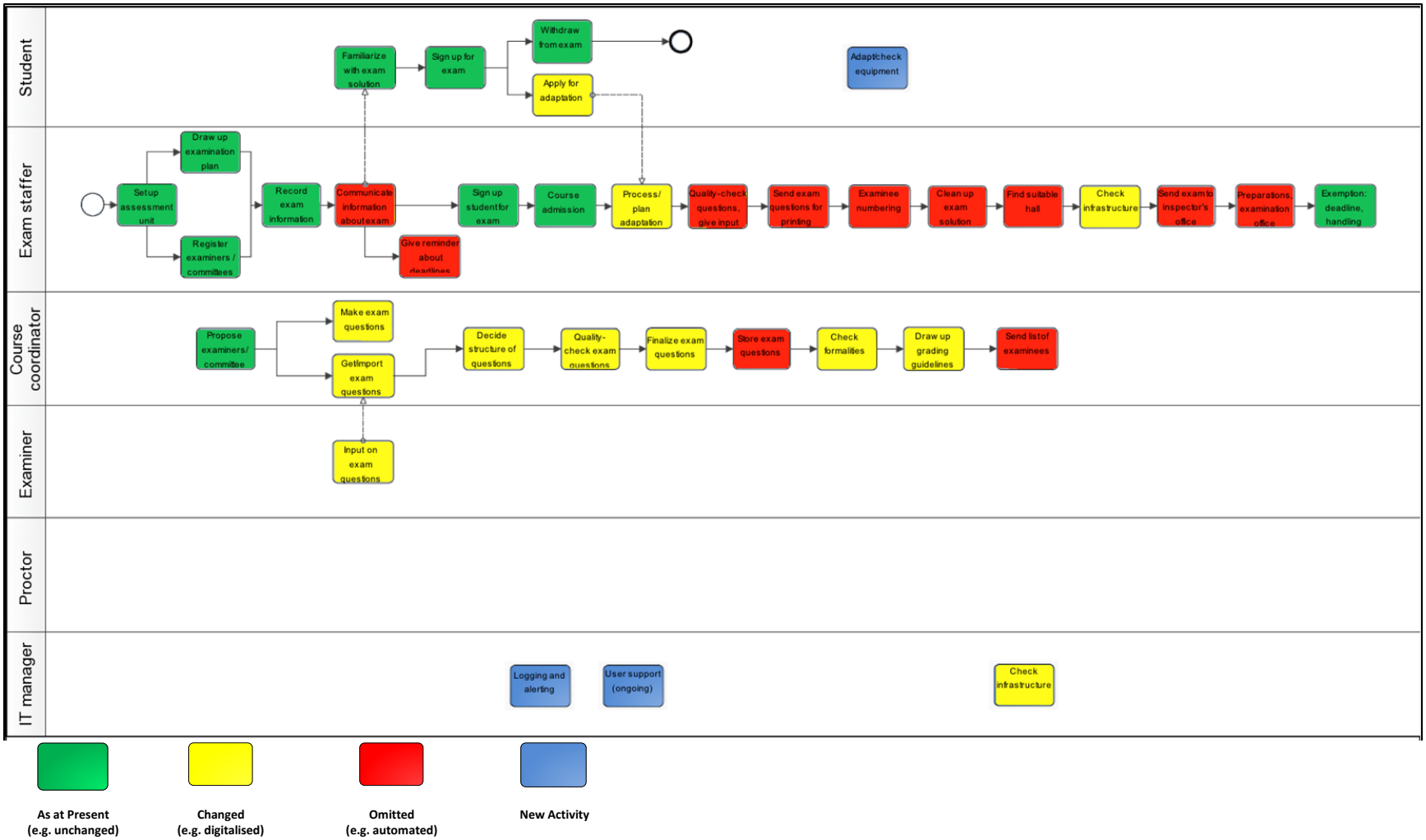
A.8.4 Finalising the exam process

In the last phase, many of the boxes are coloured yellow, meaning that they will be digitalised. In a future process, answer papers will not need to be sent manually from the exam staffer to the examiner and back again, which will save considerable time. The grading itself will also take place digitally.

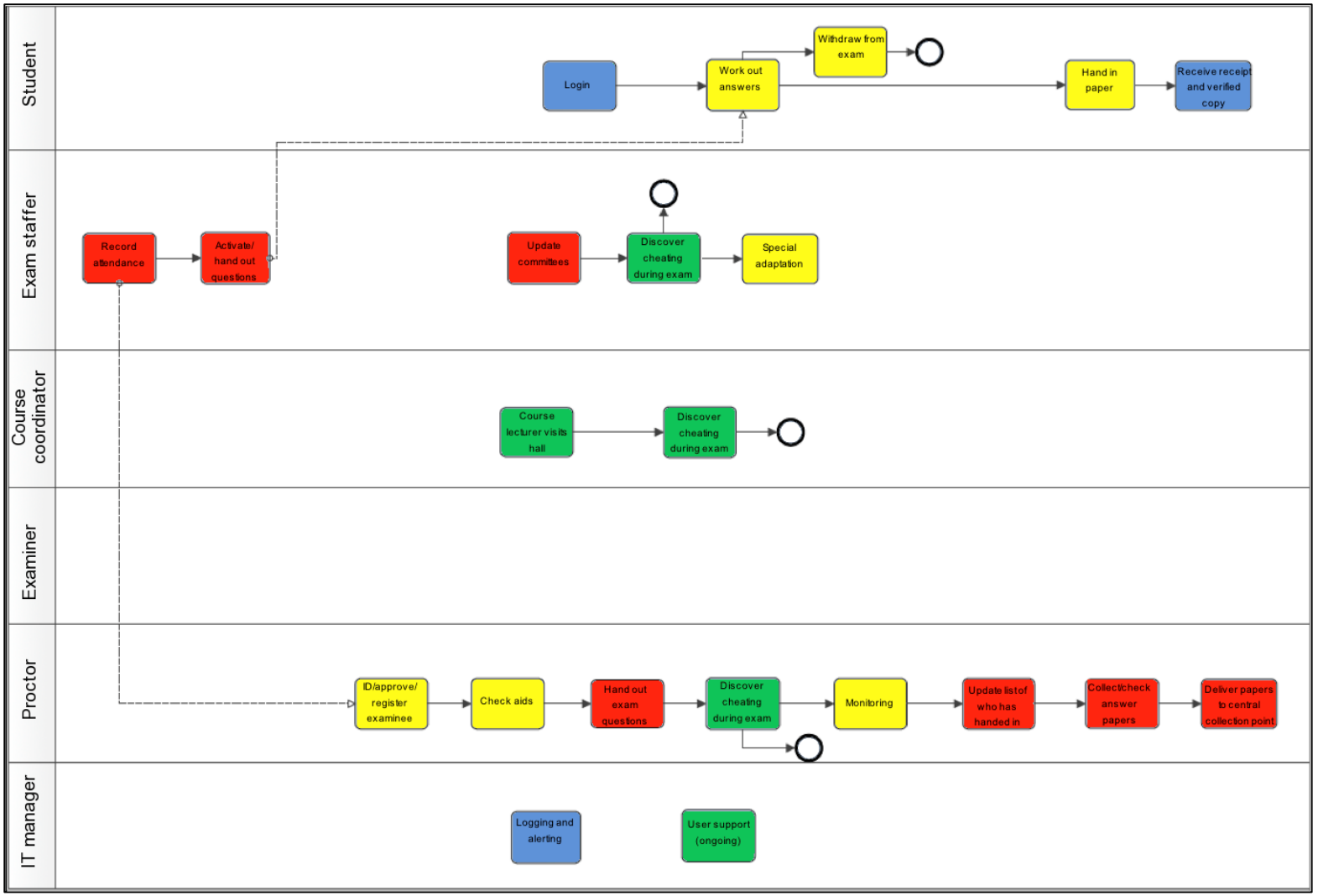
Also see Section A.9.4 for a visual presentation of the transformation to the explanation- and complaint-handling phase, storage and archiving.

A.9 Process charts for transformation from the present process to the future process

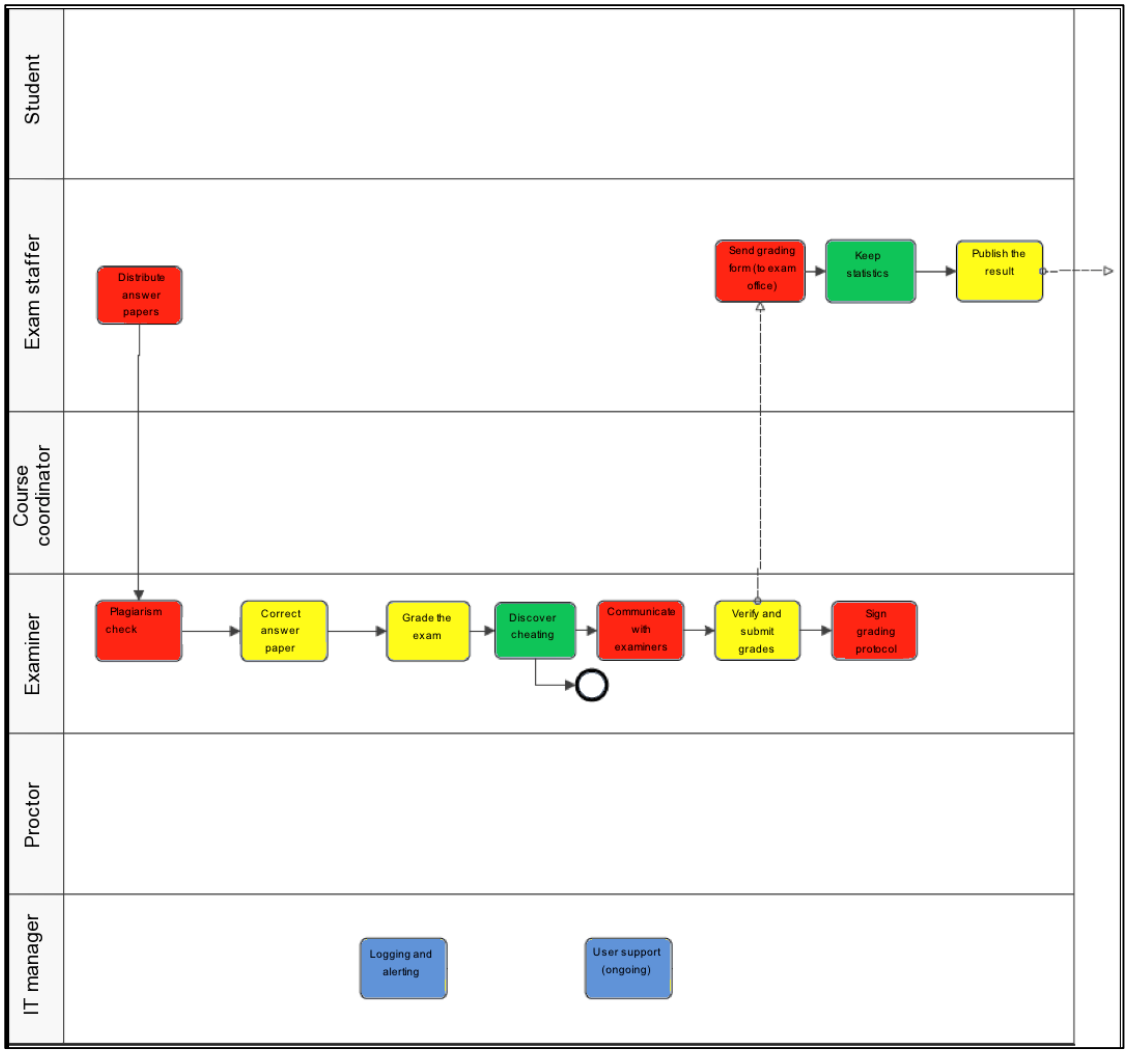
A.9.1 Preparing – process, transformation



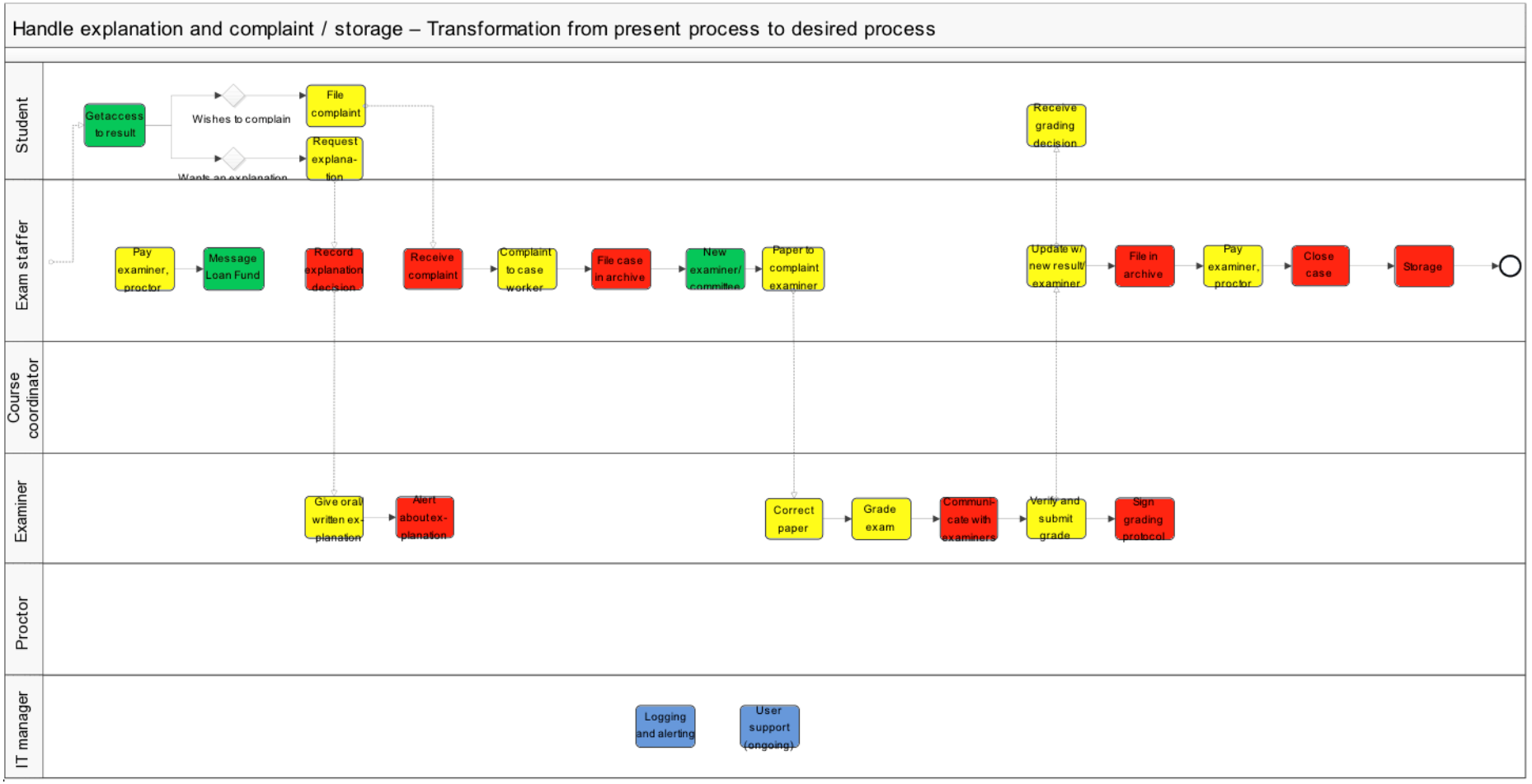
A.9.2 Carrying out – process, transformation



A.9.3 Grading – process, transformation



A.9.4 Finalising the exam – process, transformation



A.10 Overview of changes

During the workshop, explanations for the various changes were recorded in a table. This makes it easier to look up an individual activity to see why it was changed in the presentation of the future process. Furthermore, a working group member has recorded the system that is used for the activity concerned in the present process. This table sums up all the activities, roles, systems and phases, and offers explanations or comments on the changes done in the transformation from the present to the future process.

The table is structured in the same way as the process charts, and contains the same information. In addition, the table has comments in the right-hand column. The table is intended to give an overview, with the option of sorting by phases or roles. The table itself can be used as a point of departure for specification work.

The colour codes used in the following table are:

As Present (e.g. unchanged)	Changed (e.g. digitalised)	Omitted (e.g. automated)	New Activity

Activity	Role	System	Phase	Comment
Familiarisation with the exam solution	Student	Digital exam system	Preparing for the exam	
Signing up for the exam	Student	Studentweb	Preparing for the exam	
Withdrawing from the exam	Student	Studentweb	Preparing for the exam	
Applying for adaptation	Student	Paper form	Preparing for the exam	
Checking and adapting equipment	Student		Preparing for the exam	
Setting up the assessment unit	Exam staffer	FS	Preparing for the exam	
Setting up the examination plan	Exam staffer	FS, schedule system, Word/Excel, hall-booking system	Preparing for the exam	Should not involve manual transfer from one system to another in the future
Registering examiner/committee member	Exam staffer	FS, case/archive	Preparing for the exam	This also includes access control for (external) examiners and students

Activity	Role	System	Phase	Comment
Recording exam information	Exam staffer		Preparing for the exam	
Communicating information about the exam	Exam staffer		Preparing for the exam	Done automatically
Issuing a reminder about deadlines	Exam staffer	email, web pages	Preparing for the exam	Automated
Signing up student (if delayed etc.)	Exam staffer	FS	Preparing for the exam	All cases of exceptions with manual handling are kept in the future process
Admission	Exam staffer	FS	Preparing for the exam	
Handling and planning adaptation	Exam staffer	FS, case/archive	Preparing for the exam	Reduced extent
Quality-checking exam questions, giving input on changes	Exam staffer		Preparing for the exam	Replaced by the system and by the course lecturer going over a form after developing exam questions
Sending exam-question sets for printing	Exam staffer		Preparing for the exam	Only for special needs (physical adaptation)
Examinee numbering	Exam staffer	FS	Preparing for the exam	Automated
Cleaning up the exam solution and confirming printout	Exam staffer		Preparing for the exam	Automated
Finding a suitable hall	Exam staffer	FS, hall-booking system	Preparing for the exam	Automated
Checking infrastructure	Exam staffer		Preparing for the exam	Moved to IT manager
Preparations of the exam office (halls, proctors)	Exam staffer	FS	Preparing for the exam	Automated;
Sending the exam to the inspector's office	Exam staffer		Preparing for the exam	Automated
Exemption by deadline, handling exceptions	Exam staffer	FS	Preparing for the exam	All cases of exceptions with manual handling are kept in the future process

Activity	Role	System	Phase	Comment
Proposing examiners/committee	Course coordinator	FS, case/archive	Preparing for the exam	
Developing the exam questions	Course coordinator	Word, LMS etc.	Preparing for the exam	Digitalised, possibility of digital workflow and collaboration
Getting (importing) the exam questions	Course coordinator		Preparing for the exam	Digitalised
Deciding on the structure (composition) of the exam	Course coordinator		Preparing for the exam	Digitalised
Quality-checking the exam questions	Course coordinator		Preparing for the exam	Digitalised, possibility of digital workflow and collaboration
Finalising the exam questions	Course coordinator		Preparing for the exam	Digitalised
Storing exam questions	Course coordinator		Preparing for the exam	Automated
Checking formalities concerning exam questions	Course coordinator		Preparing for the exam	Time allotted, aids, universal design, language, third-party tools, plagiarism check
Drawing up grading guidelines	Course coordinator	Word etc.	Preparing for the exam	Digitalised
Sending the list of approved examinees	Course coordinator	FS	Preparing for the exam	Automated
Giving input on the exam questions	Examiner		Preparing for the exam	Digitalised
Logging and alerting	IT manager		Preparing for the exam	New activity
Ongoing user support	IT manager		Preparing for the exam	New activity
Checking the infrastructure	IT manager		Preparing for the exam	Changed role for IT manager, may e.g. involve checking BYOD
Logging in	Student		Carrying out the exam	NEW ACTIVITY Digitalised login
Working out answers/paper	Student	Paper, digital exam system	Carrying out the exam	Digitalised
Withdrawing from the exam	Student		Carrying out the exam	Digitalised

Activity	Role	System	Phase	Comment
Handing in the answer paper	Student		Carrying out the exam	NEW ACTIVITY Digitalised, it is important that the student get a receipt and a verified copy of the paper
Receiving a receipt and verified copy	Student		Carrying out the exam	NEW ACTIVITY. Automated
Recording attendance	Exam staffer	FS	Carrying out the exam	Automated. No longer needed, since the examinees are digitally recorded.
Activating the exam questions / Handing out the exam questions	Exam staffer		Carrying out the exam	Automated or digitalised (e.g. if a 10-minute delay is needed)
Updating committees	Exam staffer	FS	Carrying out the exam	Placed at the very end of the carrying-out phase. The possibility of configuring (setting up rules) for examiners, how many examinees they should have etc.
Discovering cheating during the exam	Exam staffer		Carrying out the exam	For e.g. take-home exams, one might do a running check of the examinee's identity.
Special adaptation	Exam staffer		Carrying out the exam	Moved from the IT manager because the greatest need will be for physical adaptation
Course lecturer visiting the hall	Course coordinator		Carrying out the exam	
Discovering cheating during the exam	Course coordinator		Carrying out the exam	
Identifying, approving and registering the examinee	Proctor	FS	Carrying out the exam	Digitalised. The signature is done digitally. We also need to consider other assessment forms. This applies to in-class exams, but we also want to be sure that we have the right examinee in the case of a take-home exam.

Activity	Role	System	Phase	Comment
Checking the aids	Proctor		Carrying out the exam	Partly Digitalised. Some manual work needed for the near future.
Handing out exam questions	Proctor		Carrying out the exam	Omitted
Discovering cheating during the exam	Proctor		Carrying out the exam	
Monitoring	Proctor		Carrying out the exam	Both digitalised and manual checking. How to know for sure that it is the right examinee?
Updating a list of those who have answered and handed in paper	Proctor	Paper-based list	Carrying out the exam	
Collecting and checking answer papers	Proctor		Carrying out the exam	The system might give a warning message e.g. if the submission is blank: Do you wish to submit a blank paper?
Delivering sets of answer papers to a central collection point	Proctor		Carrying out the exam	
Ongoing user support	IT manager		Carrying out the exam	Manual activity. Especially at the start and handing in. Ongoing.
Special adaptation	IT manager		Carrying out the exam	Role changed to exam staffer, since this is most often a physical adaptation
Logging and alerting	IT manager		Carrying out the exam	NEW ACTIVITY. Automatic process logging that things get saved etc., so that everything works as the exam is carried out. May also trigger the handling of cheating.
Distributing answer papers	Exam staffer		Grading the paper	NEW ACTIVITY (also include in the present). This will be automated.
Sending (storing) grading form (to exam office)	Exam staffer		Grading the paper	Omitted. No longer needed

Activity	Role	System	Phase	Comment
Keeping statistics	Exam staffer	FS	Grading the paper	This was already automated
Publishing the result	Exam staffer		Grading the paper	Partly digitalised. The option of publishing the explanation, if entered by the examiner(s).
Checking for plagiarism, discovering cheating	Examiner		Grading the paper	Role changed to system. Automated. Cheating is often discovered due to the examiner's competence.
Correcting paper	Examiner	Paper-based form, grading system	Grading the paper	Digitally supported with the option of adding an explanation for each exam question
Grading the exam	Examiner	Paper-based form, grading system	Grading the paper	Digitally supported
Discovering cheating, plagiarism	Examiner	Plagiarism checker	Grading the paper	As today
Communicating with the examiners	Examiner		Grading the paper	Omitted. Forms part of grading the exam.
Verifying and submitting the grade	Examiner		Grading the paper	Digitalised
Signing the grading protocol	Examiner	Paper-based form	Grading the paper	Omitted. No longer needed
Checking the grade	External supervisor		Grading the paper	The entire role has been omitted from the process chart. It is outside the process we have defined. External evaluation of the assessment is done by external supervisor, but this comes as part of the quality-assurance system and is external.
Logging and alerting	IT manager		Grading the paper	New activity
User support (ongoing)	IT manager		Grading the paper	New activity

Activity	Role	System	Phase	Comment
Getting access to result	Student	Studentweb	Handling explanation and complaint/ storage	
Requesting an explanation	Student	FS, case/archive	Handling explanation and complaint/ storage	Digitalised
Submitting a complaint	Student		Handling explanation and complaint/ storage	With digital support. May complain about formal errors and/or about the grade for the paper. The original grade must be barred.
Receiving grading decision	Student		Handling explanation and complaint/ storage	Digitalised
Paying the examiner, proctor	Exam staffer	FS, accounting system	Handling explanation and complaint/ storage	Digitalised
Messaging the State Educational Loan Fund about the grading decision for an examinee	Exam staffer	FS	Handling explanation and complaint/ storage	Already automated at present
Recording (storing, filing) the explanation decision	Exam staffer	FS, case/archive	Handling explanation and complaint/ storage	Automated after the examiner completes the workflow
Receiving complaint	Exam staffer	FS, case/archive	Handling explanation and complaint/ storage	Automatically entered into the system. Grade barred.
Assigning a caseworker to the complaint	Exam staffer	FS, case/archive	Handling explanation and complaint/ storage	With digital support
Registering the case in the case/archive system	Exam staffer	Case/archive	Handling explanation and complaint/ storage	Automated

Activity	Role	System	Phase	Comment
Assigning new examiners (complaint committee)	Exam staffer	FS, case/archive	Handling explanation and complaint/ storage	
Sending the answer paper to complaint examiner	Exam staffer		Handling explanation and complaint/ storage	Consider whether to include information in the case of a failing grade
Updating the case with the result from the new grading	Exam staffer	FS, case/archive	Handling explanation and complaint/ storage	Name change to: "quality-checking and publishing the result". This gets digital support. Need to check if the student has to take a new oral exam if the grade for the written exam is changed, or if other forms of exception handling are triggered.
Archiving	Exam staffer	Case/archive	Handling explanation and complaint/ storage	Automated
Paying the examiner, proctor	Exam staffer	FS/accounting system	Handling explanation and complaint/ storage	Digitalised
Closing the case	Exam staffer		Handling explanation and complaint/ storage	Automated
Storage of exam questions, grading protocol and answer paper	Exam staffer		Handling explanation and complaint/ storage	Automated
Giving a written or oral explanation	Examiner		Handling explanation and complaint/ storage	Partly digitalised. May be given orally.
Alerting the exam staffer when the explanation has been given	Examiner		Handling explanation and complaint/ storage	Complaint deadline is set automatically

Activity	Role	System	Phase	Comment
Correcting the exam	Examiner		Handling explanation and complaint/ storage	
Grading the exam	Examiner		Handling explanation and complaint/ storage	
Communicating with examiners	Examiner		Handling explanation and complaint/ storage	Omitted
Verifying and submitting the grade	Examiner		Handling explanation and complaint/ storage	Digitalised
Signing the grading protocol	Examiner	Paper-based form	Handling explanation and complaint/ storage	Omitted
Logging and alerting	IT manager		Handling explanation and complaint/ storage	New activity
User support (ongoing)	IT manager		Handling explanation and complaint/ storage	New activity

Part IV: Future process

A.11 Future processes

The future process shows the desired digitalisation of the workflow. Some of the present manual processes are partly digitalised or automated. There is much to be gained from digitalising things that are currently on paper – such as exam questions, answer papers and grading protocols - and handling them digitally. To achieve this, the work processes surrounding their production must be digitalised. With good system support, a future process will flow better between roles, which will save resources.

All automated activities must be capable of being overridden in exceptional cases. For example, there must be an option to delay the start of the exam by a few minutes if some incident has led to delays. Future systems must generally lead to less paperwork and more flexibility.

To carry out a digital exam, some of the exam staff (for example the head of staff) will need more IT knowledge than is required in the present process. It is conceivable that the holding of exams could be centrally managed to a greater extent and not managed on-site in the examination halls as is the case today.

Some processes have sub-processes, such as “creating exam questions” and “grading papers”. This is the case where we know that the type of exam or assessment affects the process, and there is a need to cover more than the traditional written in-class exam without aids. Processes with sub-processes are marked with an X. These processes must be detailed in the specification phase, as they include many activities that might influence the future choice of system.

The future process is presented visually on the following pages. The process is grouped the same way as the present process, with four main phases, as shown in Figure A3.

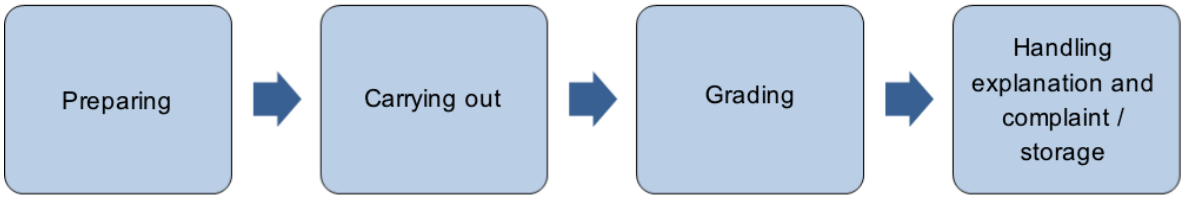


Figure A.3: The four main phases

A.11.1 Preparing for the exam – future process

The present process includes many manual activities that should be automated or omitted from a future process, or that should be digitally supported. This applies e.g. to the exam staffer and the course coordinator, who mainly develop the exam questions on paper in the present process, but should have the option of doing so digitally in a future process.

Also see the process chart in Section A12.1 for a visual presentation of the future preparation phase.

A.11.2 Carrying out the exam – future process

In the carrying-out phase, the proctor has many manual activities tied to registering the student, handing out exam questions and collecting answer papers. There will still be a need to register the student, but handing out, handing in and sending papers to a central collection place should take place digitally in the future. Activities residing with the student, such as logging in, working out answers, withdrawing from the exam and handing in the paper, should be digitalised. Activities such as recording attendance and handing out exam questions by the proctor should be changed to a digitalised form or should be wholly automated. There will be a need for special adaptation, but the extent of this activity should be reduced as exams are to be universally designed. The course lecturer will visit the exam hall, as previously. Possibly, the students might be offered the chance to ask questions digitally.

Also see the process chart in Section A12.2 for a visual presentation of the future carrying-out phase.

A.11.3 Grading papers – future process

In the grading phase, activities mainly reside with the examiner and the correcting of answer papers mainly takes place on paper. In a future process, the correcting of papers should take place digitally, so there will be no need to send papers between the exam staffer and the examiner. This will improve the flow and examiners will get quicker access to answer papers. The examiners correct the papers and the students get access to the result. The exam staffer's activities have system support in the present process, so the most significant change here is that they can get the results digitally rather than on paper. This will make the process more digital.

Also see the process chart in Section A12.3 for a visual presentation of the future grading phase.

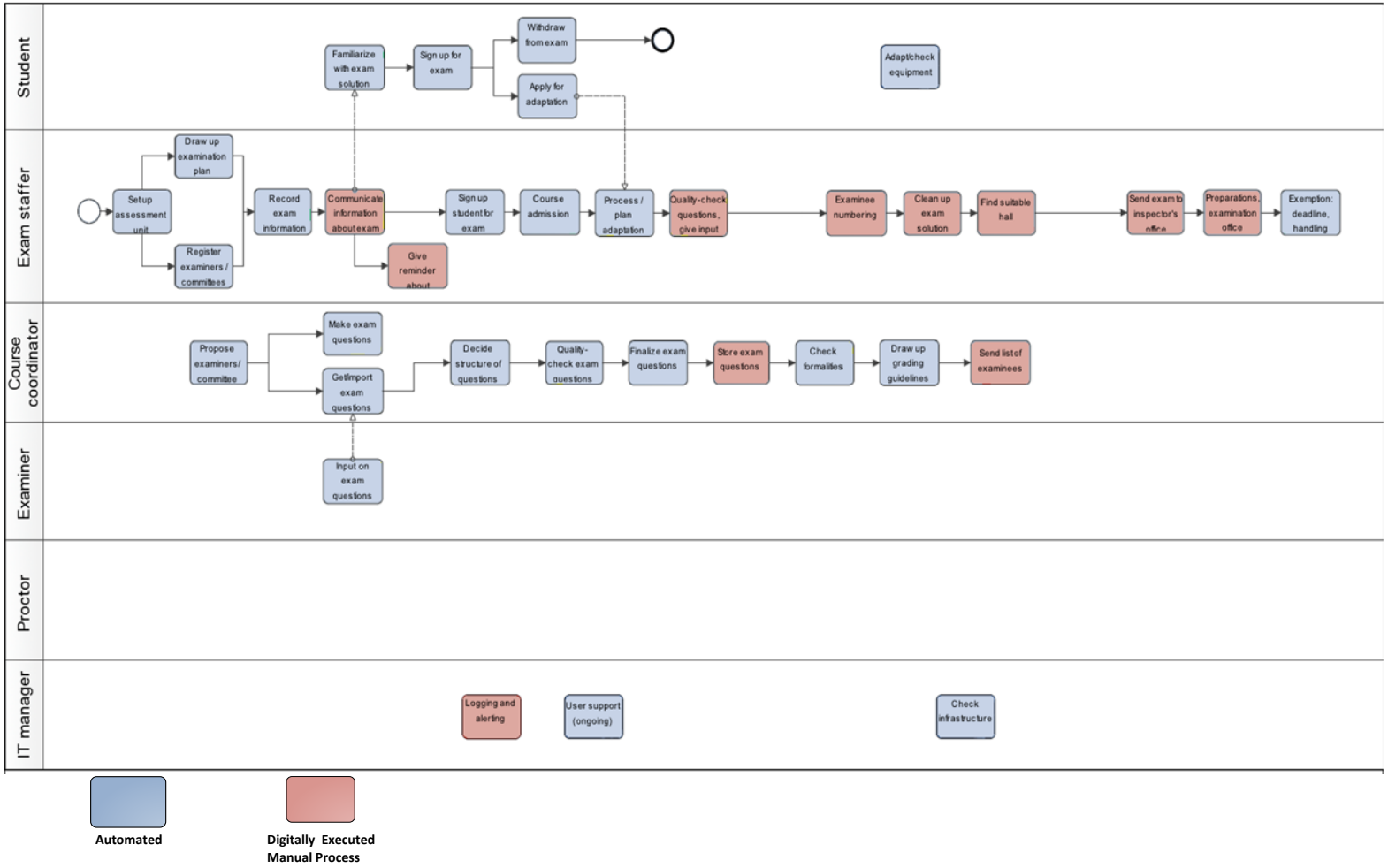
A.11.4 Finalising the exam – future process

What goes for the grading phase also goes for explanations and complaints: manual activities in the present process should be digitalised. Work in this phase will be considerably simplified compared with the present process. Digitalisation will lead to a better workflow and less sending of papers between roles.

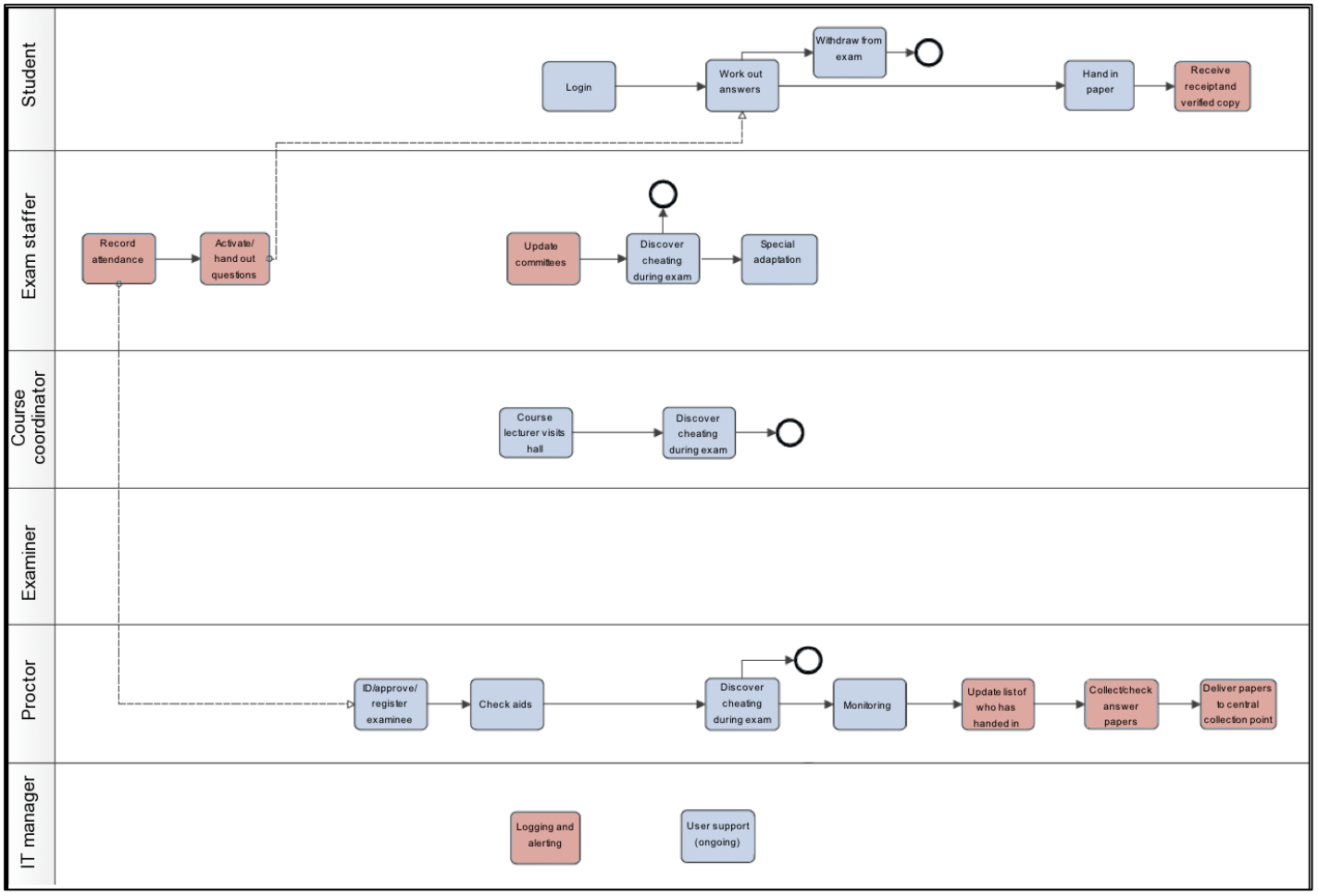
See the process chart in Section A12.4 for a visual presentation of the future phase of finalising the exam, with information on how to handle explanations, complaints, storage and archiving.

A.12 Process charts for future process

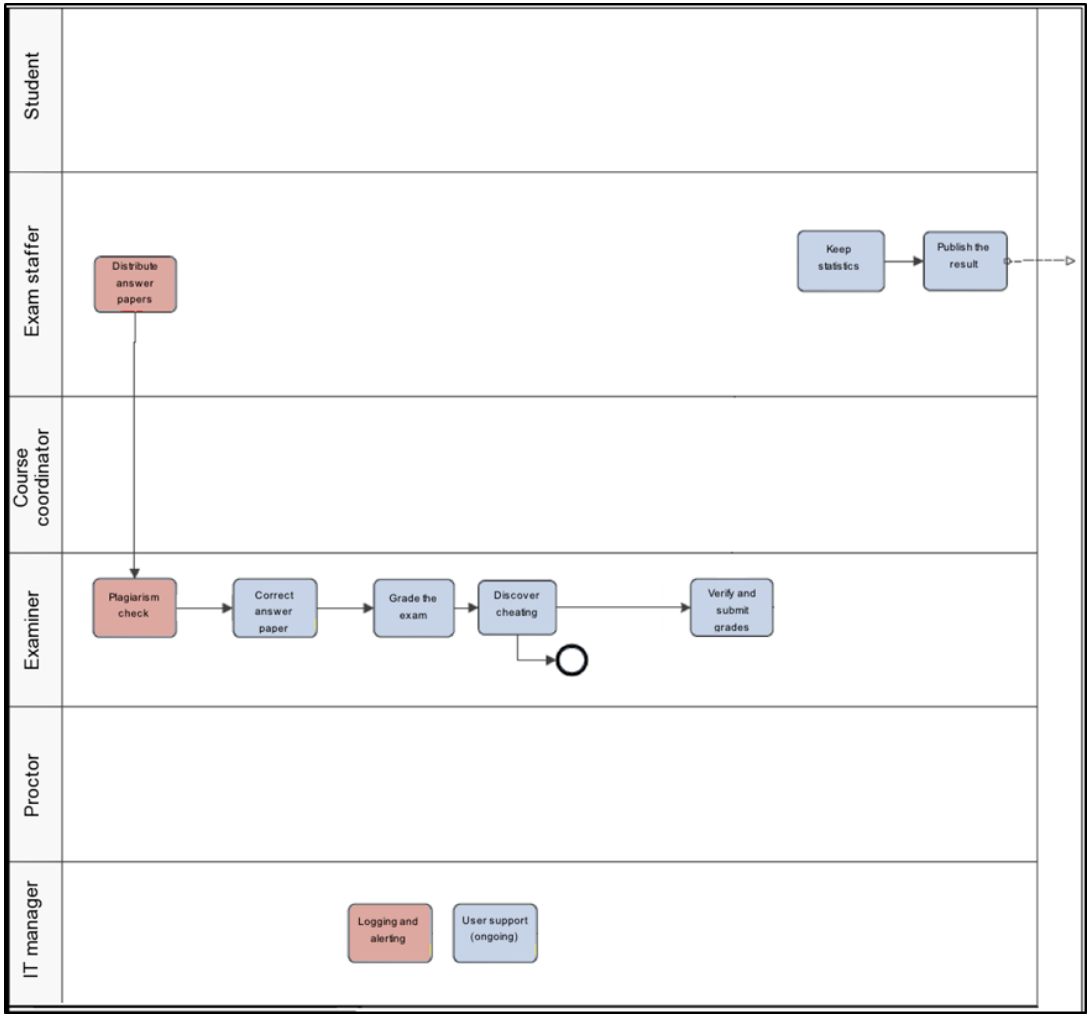
A.12.1 Preparing for the exam – future process chart



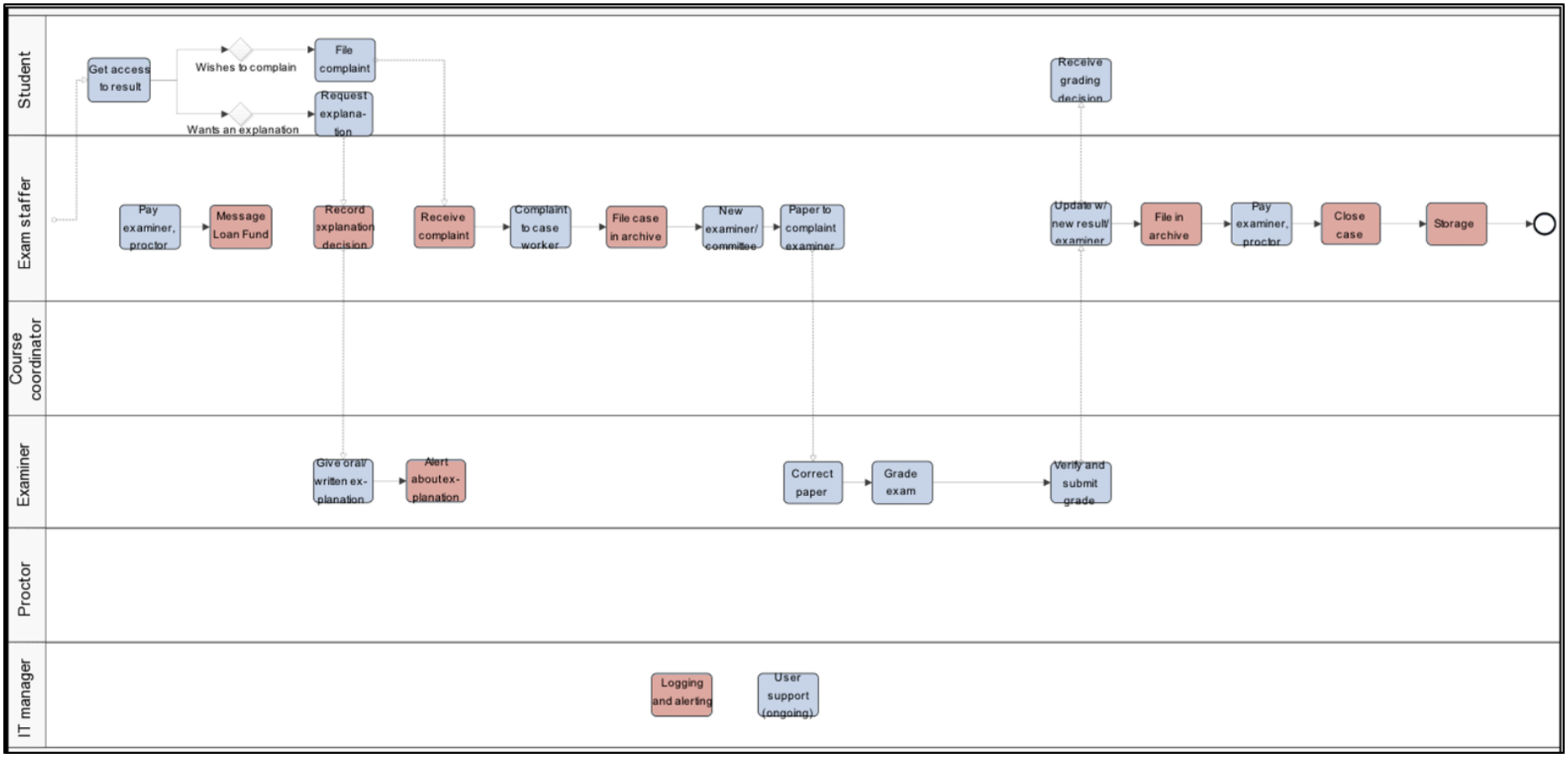
A.12.2 Carrying out the exam – future process chart



A.12.3 Grading papers – future process chart



A.12.4 Finalising the exam – future process chart



Part V: Further Work

A.13 Further Work

The process charts and the table are the outcome from the working group on digital workflows, and will be used *inter alia* as a point of departure for the work of the group on ICT architecture. There, they will form the basis for function groups, information objects and future services and interfaces.

Later on in the project's work on analysing needs and testing solutions, the summary table and the process charts could be a point of departure for the specification work on acquiring a new system or systems. At this point, there may be a need to detail individual processes further. This working memo may therefore be updated and finalised after the acquisition of a system, and make clearer recommendations on the work process.

This working memo forms part, as background information, of a series of documents recommending solutions for the holding of digital exams.

Experience gathering for the HE sector provides input for the work, as does work on local pilots and common development agreements. Some areas subject to further work in connection with the development contracts for digital exams include:

- Clarifying the work processes for the digital creation of exam questions. Even though the work has focused on digital in-class exams, there are many other examination forms with their own processes that should also be digitalised to a greater extent than at present.
- Clarifying how indications of cheating should be handled by examiners, exam staffers and other performers. It turns out that information-flow practices differ in this area. In addition, there are new information sources from the IT side that should be documented.
- Coordination of terminology. For example, the process charts use "student" where others have used "examinee" ("candidate").
- New processes must be tested and adjusted according to experience after large-scale testing. Actual experience of what works in practice must be brought into the process documentation. This is important where processes are digitalised and where they are automated, as well as where there are entirely new activities.
- Matters concerning the archiving, storage and disposal of records have not been sufficiently tested, and should be tested further before the new process is adequately understood.
- The relationship between written in-class exams and other digital assessment forms should be further assessed to elucidate where the processes are general and where they are specifically tied to digital in-class exams.

- Clarification of matters tied to procedures, documentation, requests for deletion and operational considerations concerning the logging of information tied to discovery of cheating.
- Clarification of matters tied to procedures, documentation, requests for deletion and operational considerations concerning the logging of information tied to the operational use of exam solutions, as seen from the respective points of view of the student, the IT department, and the provider.

In addition, there will be specific proposals for changes after feedback from the group on ICT architecture.

The process charts may be updated as a result of the work of the group on ICT architecture, and possibly also following input from the other working groups tied to the national project on digital exams.

The document is published in order to ensure the transparency of and input into the work on the digitalisation of exams in higher education in Norway. The document at hand presents how far the working group has come in its work at this point.

Appendix B Process Model for Digital Assessment

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Executive Summary

This appendix describes a process model for digital exams in the Norwegian HE sector. It describes each phase of a digitalised exam process with charts for the information model, a table of connections to services for each individual activity, and a short description. The phase descriptions are based on the workflow charts described in Appendix A: Work processes for digital assessment.

The phases described are

- Preparation
- Holding exam
- Grading
- Finalising

This Appendix requires familiarity with either the exam processes or the ICT architecture.

Part 1: Models

UNINETT has set up a project on digital exams under the auspices of the eCampus program. The project consists of several working groups and a steering group. The content of this document was produced by the working group on ICT architecture. The target images in this document provide recommendations for a common ICT architecture for digital exams, as well as ICT architecture in the university, and college sector in general.

In this context, an ICT architecture may be defined as a set of formal descriptions of system components, data, integrations and their structure, relations, and guiding principles. The charts of the information model have been developed with the Archi software as Archimate models, and the model is available for further work via UNINETT's web pages http://www.uninett.no/digitaleksamen.

The purpose of the reference architecture described in this Appendix is to describe an exam solution that supports a digitalised workflow for holding exams in higher education. An exam solution consists of one or more applications, but is for convenience shown as a single application.

Digital, in-class exams have been the guiding scenario for its development, but other assessment forms will also have much the same processes tied to preparing, grading and finalising the exam. The carrying out of the exam itself may differ somewhat from other examination forms, but here we have emphasised separating the workspace facing the student from the processes tied to attendance at exams, so the model should be easy to use for other assessment forms as well.

The charts are color-coded:

- Pink is used to indicate activities that take place within the exam solutions.
- Yellow is used to indicate activities that take place in systems outside the exam solutions, but where information flows to the exam solution.
- Grey is for processes that take place outside the exam system, and where information does not flow to the exam solutions.
- Dark blue is used to illustrate roles, where individuals have a role-based function.
- Light blue shows applications with activities tied to digital exams.

B.1 Overall application map

The following application map shows which applications communicate directly with the exam solution. In addition to the communication shown in the chart, several of these systems also communicate among themselves, such as the student portal and student registry, Felles studentsystem (FS).

B.1.1 Application map

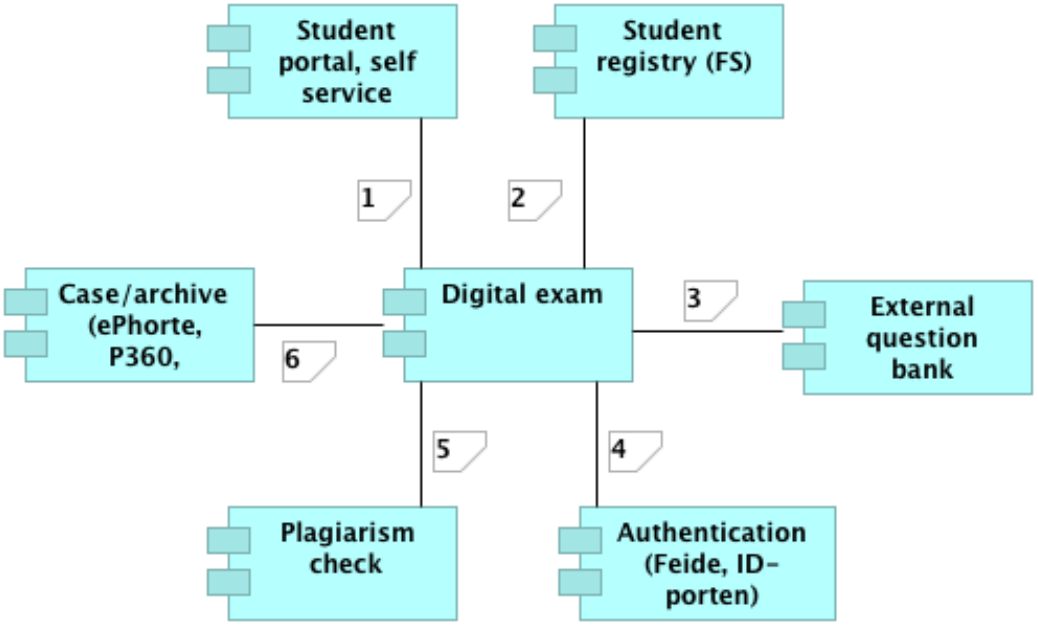

Figure B. 1: Exam solution interfaces

The interfaces to the exam solution are as follows:

- The student (self-service) portal where the examinee can enter information outside the exam situation
- The student registry system (FS) is the authoritative source for student-administration data, such as who the examinees are, how the grading committees are composed and who is the course coordinator for an assessment unit.

- The external bank of exam questions may reside with a publisher or a base of learning objects, or it could be an exam system at another institution one cooperates with on holding exams. The archive of prior exam questions may also be a question bank.
- Authentication/login takes place against external sources. Feide is widely used for students, and ID-porten for examiners, but other sources may also be used.
- To check for plagiarism, the exam answers are sent to an application that checks for text similarity and returns a text-similarity report. The relevance of text similarity is assessed by humans in accordance with the applicable requirements of good citation practices.
- The case/archive receives everything that is to be archived or dealt with as administrative casework in connection with exams. Information may flow from the casework system back to the exam solution.

B.1.2 Integration requirements

The working groups have not found any open standards covering all the needs tied to integration for digital exams. We recommend emphasising the needs tied to the academic work, in which case, the IMS standards will, in our view, cover most of the needs. This is particularly important for integration with the bank of exam questions and other places where digital learning resources flow. The standardisation of process support should be supported through the development of a common specification and further work on a common understanding of the processes.

The following overview was produced by Jan Erik Garshol in February 2015, in connection with the mapping of relevant standards for digital exams. Later the same month, IMS OneRoster appeared as a promising new option in addition to the below list.

The following standards[2] are seen as relevant and important:

- Person-related information flow in education (Personrelatert informasjonsflyt i utdanning) https://standard.iktsenteret.no/pifu http://www.imsglobal.org/enterprise/entv1p1/imsent_infov1p1.html#1425921 (PIFU-IMS, Norwegian-profile IMS Enterprise[3])
- IMS Global Learner Information Services (LIS) http://www.imsglobal.org/lis/
- IMS Global Common Cartridge (CC) http://www.imsglobal.org/cc/
- IMS Global Learning Tools Interoperability (LTI) http://www.imsglobal.org/toolsinteroperability2.cfm
- IMS Global Question and Test Interoperability (QTI) http://www.imsglobal.org/question/
- Accessible Portable Item Protocol (APIP) http://www.imsglobal.org/apip/
- IMS Global Caliper[4] (Caliper) http://www.imsglobal.org/caliper/

[2] Interoperability can be achieved if two systems are using the same profile of a standard. For the IMS standards in particular, experience shows the importance of profiling for the use cases; they are not turn-key ready between arbitrary systems.
[3] IMS LIS version 2 replaces the IMS Enterprise standard. The Norwegian profile of IMS Enterprise, PIFU-IMS, needs revising in order to reflect IMS LIS version 2. IMS Enterprise and IMS LIS are not two equal standards, so it is not certain that PIFU-IMS based on LIS will give the same values as when it was based on Enterprise.
[4] This is not a standard, but work is being done to establish it as a standard.

- Advanced Distributed Learning (ADL Net) xAPI[5] (xAPI)
  http://www.adlnet.gov/tla/experience-api/
- European Learner Mobility: Achievement Information (Europeisk modell for studentmobilitet - Prestasjonsinformasjon) (EuroLMAI) Standards Norway NS-EN 15981:2011
  ELMO exchange format http://wiki.teria.no/display/cenwslt/ELMO+CWA
- Metadata for Learning Opportunities (Metadata for læringstilbud)[6] (MLO) Standards Norway NS-EN 15982:2011.

LIS, CC and LTI are the main IMS standards supporting 'Digital Learning Services'. LIS describes the information elements and how they relate to one another. CC describes how the information elements should be packaged and exchanged between various parties. LTI describes how the content should be presented in a given context (application integration).

IMS LIS in particular is an extensive standard with considerable relevance to the information model for digital exams. It has the following parts:

- Person Management Service Information Model
  http://www.imsglobal.org/lis/lisv2p0p1/PMSInfoModelv2p0p1.html
- Course Management Service Information Model
  http://www.imsglobal.org/lis/lisv2p0p1/CMSInfoModelv1p0p1.html
- Group Management Service Information Model
  http://www.imsglobal.org/lis/lisv2p0p1/GMSInfoModelv2p0p1.html
- Outcomes Management Service Information Model
  http://www.imsglobal.org/lis/lisv2p0p1/OMSInfoModelv1p0.html
- Membership Management Service Information Model
  http://www.imsglobal.org/lis/lisv2p0p1/MMSInfoModelv2p0p1.html
- Bulk Data Exchange Management Service Information Model
  http://www.imsglobal.org/lis/lisv2p0p1/BDEMSInfoModelv1p0p1.html

IMS QTI is a more detailed standard. It describes the field of the content provider (questions, author and publisher), the developers of query systems and content tools, delivery tools and learning systems.

Learning resources are often described with the aid of Dublin Core: cf. standards such as ISO Standard 15836:2009, ANSI/NISO Standard Z39.85-2012 and IETF RFC 5013, IEEE 1484.12.1 – 2002, and IMS Learning Resource Metadata specification (IMS LRM). When 'free-text' descriptions are used, it is often possible to create partial Dublin Core descriptions automatically.

Information Technology - Learning, education and training - Metadata for learning resources (ISO/IEC 19788), often referred to as MLR, is a standard with about 10 parts, some of which are final while others are still in progress.

A recommendation for further work on integrations is documented in Section B12.

[5] This is not a standard, but an API that has been submitted for standardisation through the IEEE. It was rejected, and work is being done on version 2, which may become an IEEE standard.
[6] The aim of the standard is to let the learner form a qualified opinion on whether the offer is relevant or not; a link to further information is to be offered. The standard lacks a vocabulary to ensure semantic interoperability, as this is information that will quickly go out of date.

B.2 Overall information model

The information architecture describes the structure and relationships of the information resources. This section describes the various information objects, their mutual relations and their relations to the previously defined services, in terms of which services form authoritative sources and which services need to consume information objects.

B.2.1 Information elements

The following model describes the information elements in a digitalised exam solution, with the relationships among the elements.

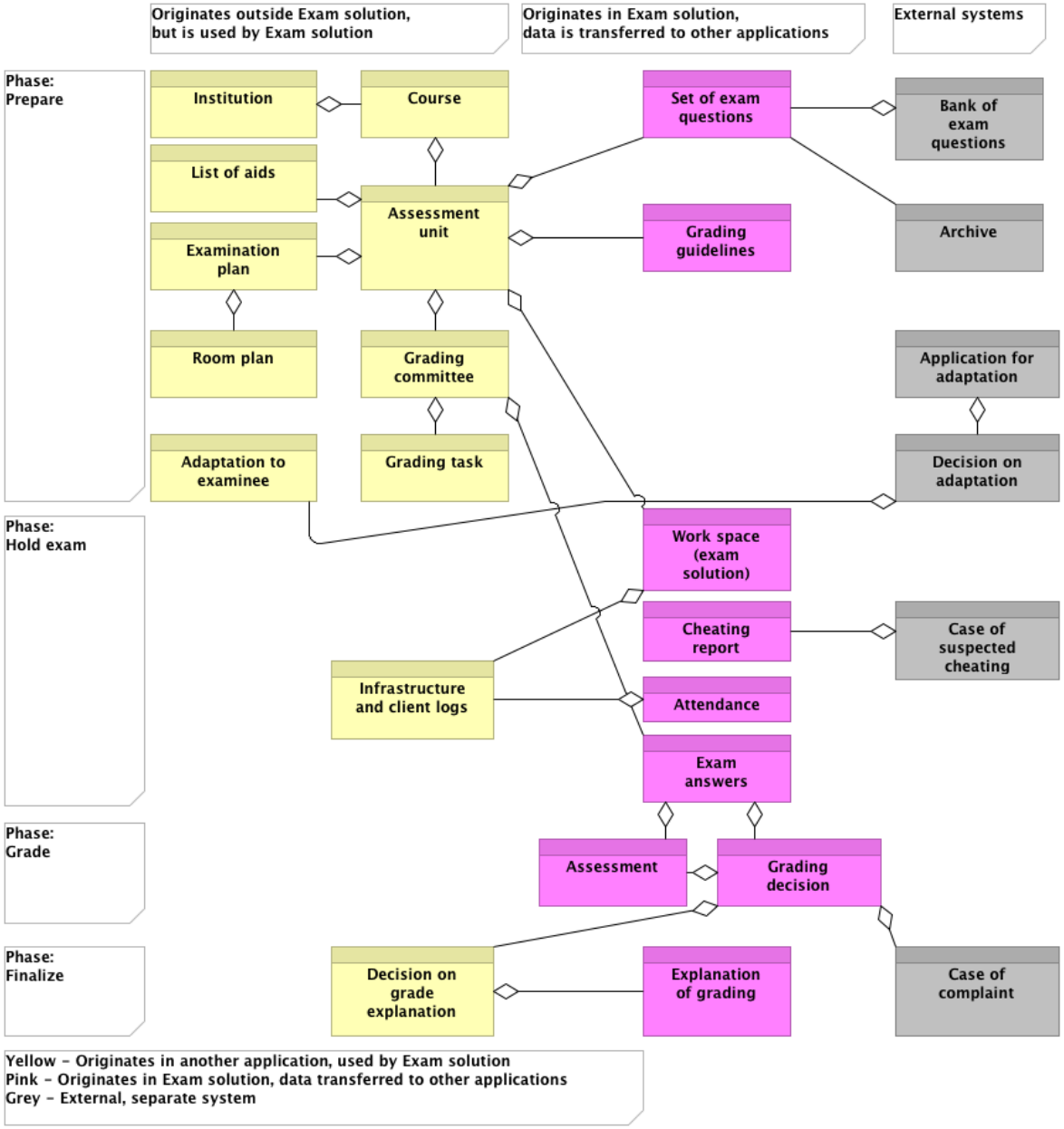

Figure B.2: Information elements in an exam situation

There are also a number of information elements tied to a digital exam solution, as seen below in Table B.1.

Information element	System (source)	Definition
Assessment unit	Student Registry	Assessment for a course. May consist of various work requirements and sets of questions. A course can have several assessment units, e.g. if it extends over several semesters with an exam in each semester.
Examination plan	Student Registry	Plan for holding the exam, with information on halls, venues, times etc.
Grading task	Student Registry	Examiner associated with a committee
Course	Student Registry	A course is the smallest unit yielding results in the form of credits and forming part of the regular teaching of the institution.
Application for adaptation	Student Registry or case/archive or student portal	Application from the student for adaptation
Adaptation decision	Student Registry or case/archive	Message to the student from the examination office/institution
Adaptation to the examinee	Academic admin	Specific adaptation to the needs of an examinee, e.g. more time or access to a spellchecker
Set of exam questions	Exam	Sets of exam questions consist of 1..N questions
List of aids	Exam	List of approved aids
Grading guidelines	Exam	The requirements against which the examiner is to judge the answer paper
Exam answers	Exam, alternatively LMS/hand-in	A document or set of files answering the exam questions. The student works out and hands in his/her answers to the set of exam questions.
Cheating report	Plagiarism checker and logs Via exam system to case/archive if suspected	Information from automated surveillance systems, including the plagiarism-checking system. Indicates cheating; may lead to filing a case of suspected cheating Information on indications of cheating is to be handled according to particular rules of procedure and confidentiality
Attendance	Exam	Record of attendance and list from ID check
Grading protocol	Exam	A report including all the examinees associated with a committee with grading decision (grades awarded) and examiners
Grading decision	Exam	The result of the committee's total assessment of an answer paper
Explanation decision	Student Registry	Could be general for all students taking an exam, or created per student on request. The latter is more usual.

Information element	System (source)	Definition
Explanation	Exam	Students are entitled to an explanation for the grading decision upon request.
Case of complaint	Student Registry	Complaint about the grading decision (grade awarded)
Room plan	Student Registry, Scheduler, Calendar	Physical space for the exam, including infrastructure
Workspace	Exam	Virtual space for the exam within the exam solution
Committee	Student Registry	A group of examiners assembled by the educational institution to assess answer papers in a particular assessment unit for a given group of examinees.
Case of suspected cheating	Casework (case/archive)	A suspicion of cheating implies that a case is filed. The underlying materials may come from a report on cheating, from proctors or from other sources.
Infrastructure and client logs	Infrastructure and client	Logs from infrastructure elements (network etc.) and from exam-client equipment
Bank of exam questions	Bank of exam questions	Sets of exam questions are composed of questions from many sources, including textbooks, digital learning resources, exam systems of partner institutions, publishers, etc.

Table B.1: Information elements tied to a digital exam solution:

Information elements originating in support systems should abide by the definitions given therein, e.g. for the exchange of results http://www.fellesstudentsystem.no/applikasjoner/resultatutveksling/

B.2.2 Information elements with associated roles

The following chart provides another perspective on the same information elements, coupled to roles:

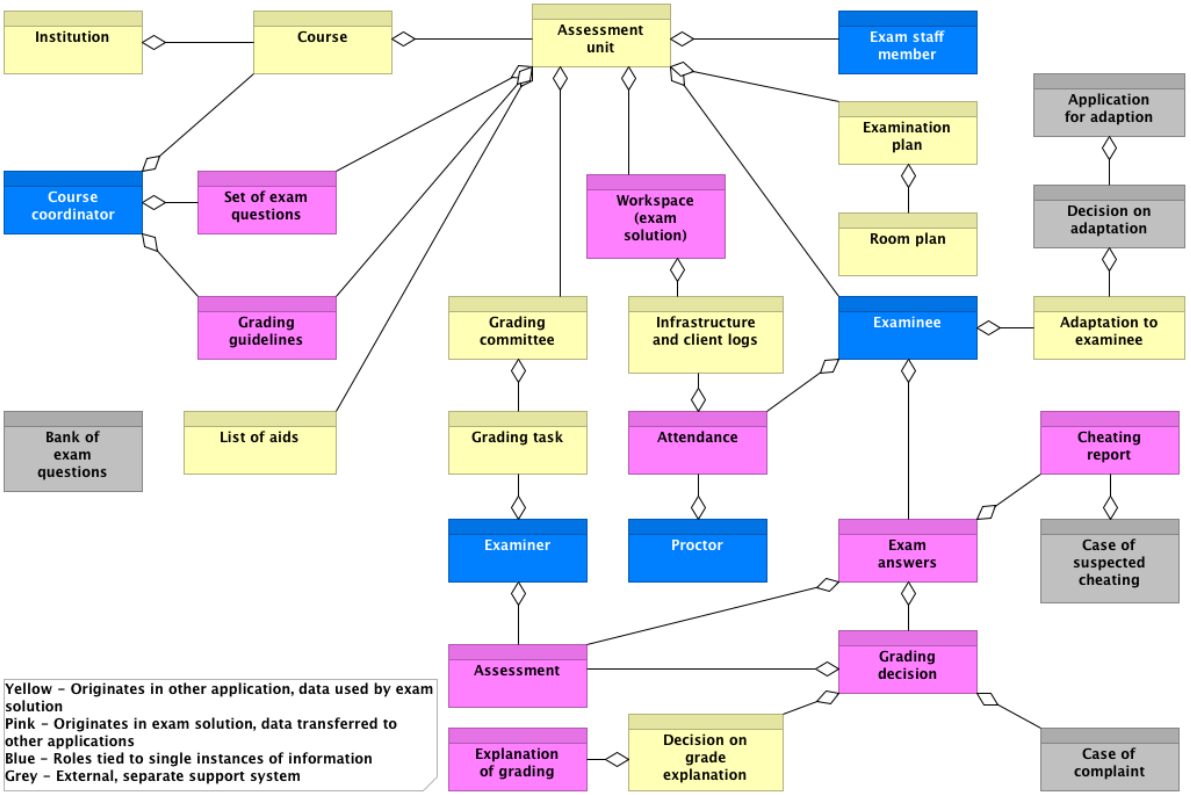

Figure B.3: Information elements in an exam situation

Roles defined by the working group responsible for the process charts and the workflow description.

Roles	Definition
Examinee	The person who is a candidate for the exam (student, external candidate or other) in a specific assessment unit
Exam staff	Administration employee with administrative activities tied to exams at the institution
Course coordinator	The person who carries out academic activities tied to the exam (develops exam questions, grading guidelines. Typically the course lecturer, employed by the institution.)
Examiner	Person assessing the examinee's performance. May be internal or external.
Proctor	Person physically present during the holding of the exam, ensuring that it is carried out according to the regulations.
ICT support	ICT support for the entire exam-related work process, including operation, user support, building infrastructure, technical surveillance and the handling of ICT security.

Table B.2: Roles defined by the working group responsible for the process charts and the workflow description

B.2.3 Information flow

Information that is to be archived in accordance with requirements for materials of archival value, such as sets of exam questions, is to be transferred from the exam solution to the archive system. The archive system thereby becomes the authoritative source for the further use of this information, in accordance with the principle of a single authoritative source for each data element. Likewise, there is a good deal of administration casework tied to exams (complaints, cheating, applications and decisions), which should take place outside the exam solution.

Elements	Where the element is used
Set of exam questions	Developed by the course coordinator for the assessment unit. May gather information from a bank of exam questions or other sources. When the exam is finalised, the set of exam questions is transferred to the archive solution.
Grading guidelines	Drawn up by the course coordinator for the assessment unit in question; used by the examiner when assessing the answer paper.
Attendance	Stores information on the examinee's participation. The proctor, exam staffer and course coordinator have different tasks related to checking and managing the examinee.
Workspace	Digital exams are taken in a workspace that needs to be familiar (student training and testing), monitored (proctor, infrastructure and client logs), and access-controlled (authentication).
Exam answer paper	Worked out by the examinee; stored in the exam solution until the exam is completed. Answer papers that are to be archived are transferred to the archive system.
Assessment	Done by the examiner. May contain grading notes.
Grading decision	The final assessment, grade awarded.
Cheating report	Information from the plagiarism checker and other sources monitoring indications of cheating. All casework tied to suspected cheating take place outside the exam solution. Logs and plagiarism-check reports are sent to the case officer.
Explanation of grading	Given by the examiner when the institution requires. May be done for all students, or only upon request, the latter being more usual.

Table B.3: Elements originating in the exam solution

B.3 Overall description of services

Service orientation is one of the basic principles in the work on ICT architecture. This section describes the services identified by the working group on ICT architecture based on the process charts from the working group on workflows [as discussed in Appendix A].

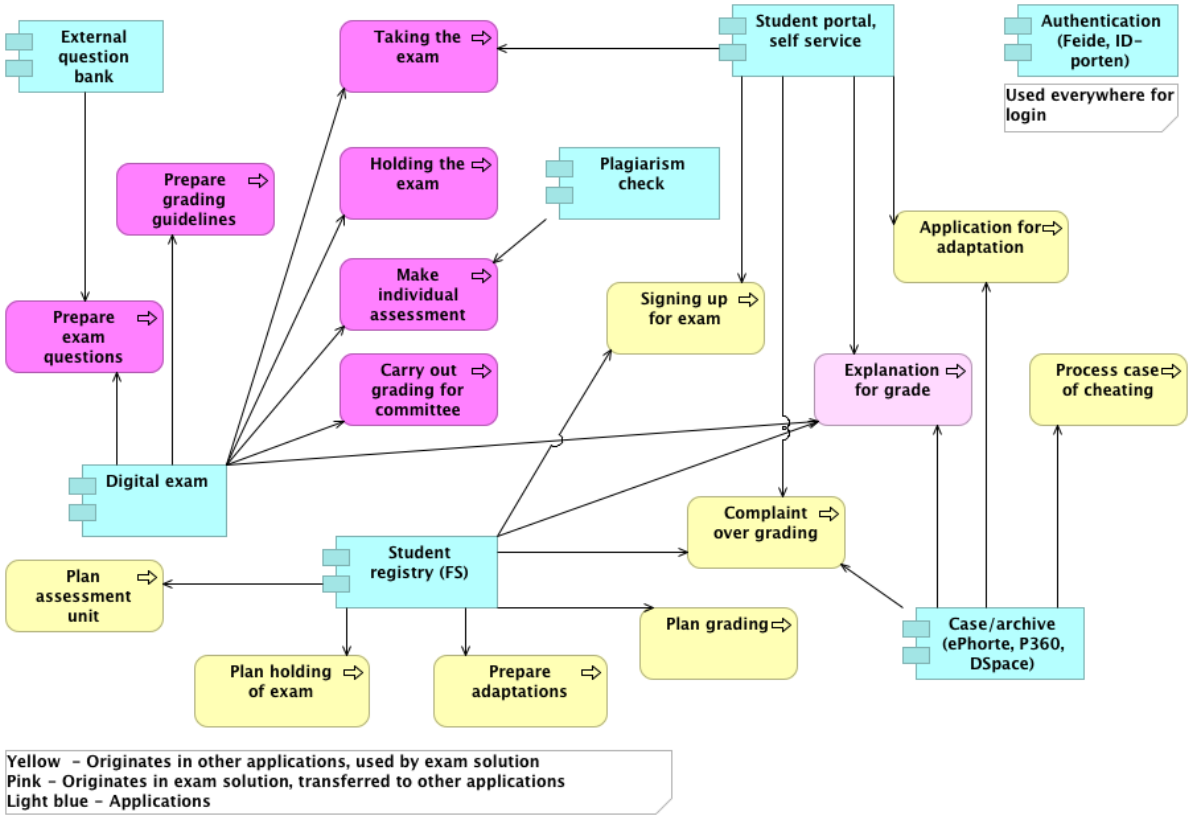

Figure B.4: Information elements in an exam situation

The description of work processes for digital assessment [Appendix A] uses the term ”process” for activities or workflows with several activities. In the following, the term process is used in the narrower sense of a workflow that is delimited by a triggering event and a completion condition, and that has a limited purpose. Services are tied to processes as shown in the following table. The further analysis uses the services and ties activities to each service (see Parts II-V of this Appendix).

B.3.1 Table of services

The table uses pink as a colour code for states arising in the exam solution and yellow for states that arise from support systems outside the exam solution but are used within the exam solution.

The services that make up the target image for the service architecture are described, as follows.

Service	Process	Triggering event	Completion condition	Description
Signing up	Signing up for the exam	The wish to sign up for an exam or a course	The examinee receives confirmation of signing up	Registers a candidate for a specific assessment unit if the person is qualified

Service	Process	Triggering event	Completion condition	Description
Attendance	Taking the exam	The examinee's attendance is recorded or the examinee hands in a take-home exam	Either the examinee has withdrawn, or an exam result is available	Authentication and checking against a list of examinees, may also include taking the exam under the supervision of proctors.
Application for adaptation	Application for adaptation	The examinee has a need for special adaptation	An adaptation decision is available	Needs are assessed and the type of adaptation is decided
Complaint over grading	Complaint over grading	The examinee wants a reassessment	The result of a reassessment is available	The grading itself is carried out with the aid of the exam system through the process "carry out grading"
Request for explanation	Explanation for grade	The examinee wants an explanation for the grade	A written or oral explanation is available	The explanation is given by the examiner through the exam system
Archiving	Archiving	A process needs archiving	Archiving is completed	This is a general service used by many processes in order to comply with laws etc.
Process suspected cheating	Handling a case of cheating	Cheating is suspected	A decision on cheating is available	Initiated either when the exam is held or during grading
Preparation of exam questions	Preparing exam questions	Assessment-unit planning completed	Set of exam questions ready for carrying out the exam	
Grading guidelines	Preparing grading guidelines	Assessment-unit planning completed	Grading guidelines ready for grading	Tied to preparing exam questions, but with a different time sequence. Grading guidelines need not always be made.
Planning the grading	Planning the grading	Assessment-unit planning completed	Grading tasks assigned, committees ready for grading	
Planning the holding of exams	Planning the holding of exams	Assessment-unit planning completed	Period/hall and detailed arrangements ready to be carried out	

Service	Process	Triggering event	Completion condition	Description
Grading committee	Carrying out grading for the committee	All papers handed in for the assessment unit are ready to be graded	All submissions or activity assessments from the committee are finally approved	
Individual assessment	Make individual assessment	The exam answer paper has been handed in or the examinees are ready for their activity to be evaluated	Individual assessments are ready for the total assessment of the committee	This is each individual assessment performed by an examiner of a paper/activity as part of a committee
Adaptation	Prepare adaptation	Regular review of adaptation decisions	Adaptation for the candidate planned and ready	Here adaptation for each candidate is planned, with the venue, PC tools etc. The implementation takes place as part of other processes.
Carry out the exam	Holding the exam			Tied to Attendance, Workspace
Planning an assessment unit	Setting up an assessment unit	Course descriptions and what courses are to be completed in the following semester	Assessment unit set up	Common scheduling for the assessment units taking account of students and available venues
Training		Persons in their roles (examinee, proctor) need training	Training completed	This is a general service used by several processes

Table B.4: Services that make up the target image for the service architecture

Note that in Table B.4, pink = states arising in the exam solution and yellow = states that arise from support systems outside the exam solution but that are used within the exam solution.

To make the process charts easier to read, in the subsequent analysis we have chosen not to chart services for everyday activities, such as: archiving, login and administrative tasks tied to the information flow in the further analysis. We assume that casework will take place following the existing casework systems.

B.3.2 Information flow for the services

The table shows the flow of information for each service. The columns show the information required for the process, and the information provided by the process. Information flows into or out of the exam solution are indicated (as shown by pink colour in the information model).

Service	Required information	Into exam solution	Out of exam solution	Provides
Signing up	From the student's signing up	Examinees tied to the assessment unit		Information on signing up
Attendance	Examinees tied to assessment unit	Login	Attendance, answer paper, attendance record	Exam answers (in answer paper)
Application for adaptation	Application			Adaptation decision
Complaint over grade	Individual assessment	Grading committee, individual assessment	Grading protocol	Grading protocol
Explanation for grade	Individual assessment, access to grading info	Individual assessment	Explanation	Explanation
Archiving	What endpoint system should have the information?		Exam questions, grading protocol, answer paper	Materials of archival value, materials for storage
Case of suspected cheating	Logger, proctor info, examiner's observations		Cheating report	Cheating report
Preparing exam questions	Course, curricular requirements	Questions from question bank		Set of exam questions
Grading guidelines	Set of exam questions			Grading guidelines
Planning the grading	Who, when, etc.?	Grading committee info		Grading committee
Planning the holding of exams		Assessment unit		Assessment unit
Grading committee	Grading committee, grading guidelines	Grading committee, grading guidelines	Grading protocol	Grading protocol
Individual assessment	Answer paper	Answer paper	Grading protocol	Grading protocol
Adaptation	Adaptation decision	Adaptation decision for the candidate per assessment unit		Specified adaptation (time, space, equipment, software)
Carrying out the exam		Assessment unit		Attendance

Service	Required information	Into exam solution	Out of exam solution	Provides
Planning the assessment unit	Course description	Assessment unit		Assessment unit

Table B.5: Service information flows

Part II: Preparations

B.4 Information model

The following chart describes the activities identified in Appendix A for the preparation phase, connected with the information model described in Section B2.

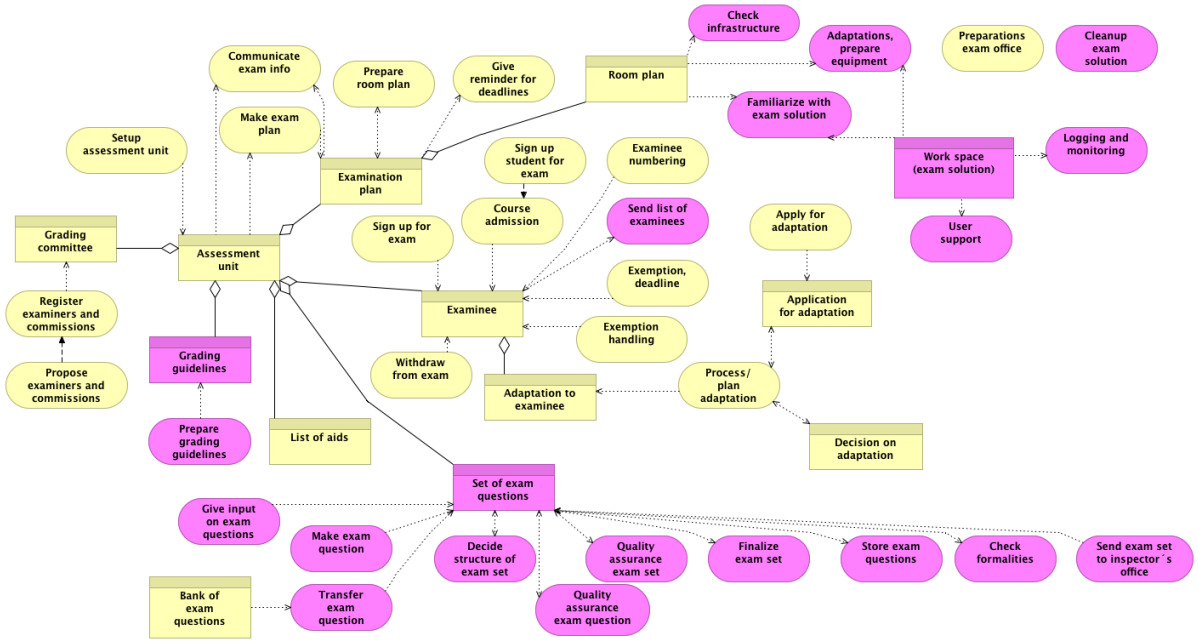

Figure B.5: Information elements in an exam situation

B.5 Table of activities and services, preparations

The table shows the relationship between the services discussed in Section B.3, and the activities discussed in Section A10. The same color-coding is used as in Appendix A:

- Green: the same workflow as today
- Blue: a new workflow as a consequence of digital case flow
- Red: automated workflow
- Yellow: changed the workflow as a consequence of digitalisation

Three changes have been made compared to the workflow charts for the preparation phase:

- Added setting up the assessment unit as a separate activity
- Changed the category for "*Familiarise with the exam solution*" to blue for a new activity in the digital context. Even with a known exam solution, new workspaces may mean that the activities have to be carried out per assessment unit.
- Split the checking of PCs into three activities
    - Setting up institutional PCs for the exam
    - The examinee's own equipment must be checked to see if it has the necessary capabilities for the exam or if the examinee needs to borrow equipment
    - The examinee's own equipment must be checked to see if it has been compromised (e.g. virus problems); this should be done shortly before the exam

Activity	Service	Comment	Exam solution or support system
Familiarise with exam solution	Planning the holding of the exam	New	Exam solution
Sign up for exam	Signing up	Student portal	Support system
Withdraw from exam	Signing up	Student portal	Support system
Apply for adaptation	Adaptation	Casework	Support system
Adapt/Check equipment	Attendance	Split into several activities based on use of BYOD or institutional PC	Exam solution and support systems
Set up the assessment unit	Planning the holding of the exam		Support system
Draw up an examination plan	Planning the holding of the exam		Support system
Register the examiner/committees	Planning grading		Support system
Register the exam information	Planning the holding of the exam		Support system
Communicate exam information	Planning the holding of the exam	Automated	Support system
Issue reminder about deadlines	Planning the holding of the exam	Automated	Support system
Sign up (if delayed etc.)	Signing up	FS	
Course admission	Signing up	FS	Support system
Process/plan adaptation	Adaptation	Casework	Support system

Activity	Service	Comment	Exam solution or support system
Quality-check the exam question, give input on changes	Preparing exam questions	Exam solution	Exam solution
Send the exam questions for printing	Preparing exam questions	Digitally in exam solution	Exam solution
Examinee numbering	Planning the holding of the exam	Automated	Support system
Clean up the exam solution and confirm printout		Automated	
Find a suitable hall	Planning the holding of the exam	Automated	Support system
Check infrastructure	Training and preparation	It support	Support system
Preparations, examination office (venues, proctors)	Planning the holding of the exam	Automated	Support system
Sending the exam to inspector's office	Planning the holding of the exam	Automated	Support system
Exemption, deadline/exemption handling	Signing up		Support system
Propose examiners/committees	Planning grading		Support system
Make exam questions	Preparing exam questions		Exam solution
Get (import) exam questions	Preparing exam questions		Exam solution
Decide on the structure (composition) of the exam	Preparing exam questions		Exam solution
Quality-check the exam questions	Preparing exam questions		Exam solution
Finalise the exam questions	Preparing exam questions		Exam solution
Store the exam questions	Preparing exam questions	Exam solution	Exam solution
Check formalities regarding the exam questions	Preparing exam questions		

Activity	Service	Comment	Exam solution or support system
Draw up grading guidelines	Grading guidelines		Exam solution
Send the list of approved examinees	Planning the holding of the exams	Automated	Support system
Input on the exam questions	Preparing exam questions		Support system
Logging and monitoring	Planning the holding of the exams	Configure and set up, alert and document	Various, including exam solution
Ongoing user support	Training and preparation		Support system
Check infrastructure	Planning the holding of the exams	Check that the hall meets infrastructure requirements	Support system
Check PC capabilities	Planning the holding of the exams	Check if PCs/Macs have the capabilities for an exam with the chosen solution	Exam solution
PC examination mode	Planning the holding of the exams	Set up/blank out institutional PC	Exam solution and PC setup
Check PC for viruses etc.	Attendance	Check PCs/Macs for viruses etc. the day before the exam	External
Set up the assessment unit		Set up by the exam staffer	Support system

Table B.6: Relationship between activities, services and preparations

Note that in Table B.6, Green = the same workflow as today, Blue = a new workflow as a consequence of digital case flow, Red = automated workflow and Yellow = changed the workflow as a consequence of digitalisation.

Part III: Hold exam

B.6 Hold exam: Information model

The following chart describes the activities identified in Appendix A for the carrying-out phase, connected with the information model described in Section AB.2.

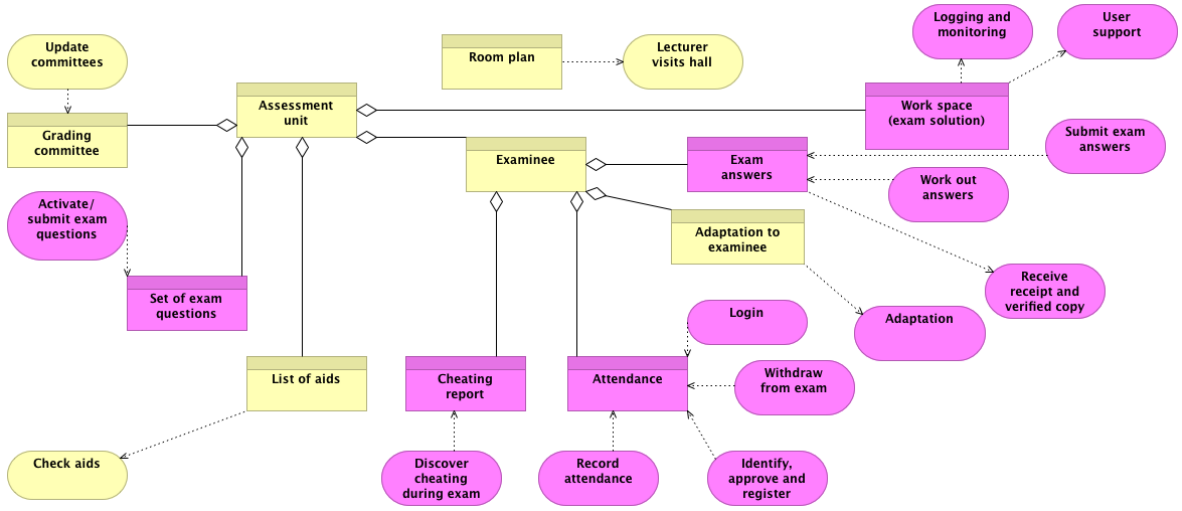

Figure B.6: Activities identified in Appendix A for the carrying-out phase

B.7 Table of activities and services – carrying out

This table shows the relationship between the services discussed in Section B3, and the activities documented in Section A10. The color-coding is the same:

- Green: the same workflow as today
- Blue: new workflow as a consequence of digital case flow
- Red: automated workflow
- Yellow: changed workflow as a consequence of digitalisationigitalisation

One change has been made compared to the workflow charts:

- Distinguishing the reporting of suspected cheating as a separate process, to have a clear divide between registering possibly relevant observations and casework tied to suspicion.

Activity	Service	Comment	Exam solution or support system
Login	Attendance	Feide integration. Access control for the workspace	Exam solution
Work out answers	Attendance	Done in the workspace	Exam solution

Activity	Service	Comment	Exam solution or support system
Withdraw from exam	Attendance	Tied to the information element Attendance	Exam solution
Hand in answer paper	Attendance	Attendance and workspace	Exam solution
Receive receipt and verified copy	Attendance	Attendance	Exam solution
Record attendance	Attendance	Automated	Exam solution
Update committees	Planning grading	Automated	
Discover cheating during the exam	Carrying out the exam		Exam solution and others
Adaptation	Attendance	May require Workspace arrangements or changes of time in Attendance	Support system
Lecturer visits hall	Carrying out the exam	"Consolation round". Quality-check of the exam questions	Course coordinator
Discover cheating during the exam	Carrying out the exam		Proctor
Identify, approve and register the examinee	Carrying out the exam	Attendance. Consider connection with cheating, formalities	Exam solution
Check aids	Carrying out the exam	Proctor	Proctor
Hand out exam questions	Carrying out the exam	Automated	Exam solution
Discover cheating during the exam	Carrying out the exam		Support system
Monitoring	Carrying out the exam	Proctor, It support, client logs etc.	Exam solution
Update the list of who has answered and handed in	Attendance	Automated	Exam solution
Collect and check answer papers	Attendance	Automated	Exam solution
Deliver the answer papers to central collection point	Carrying out the exam	Automated	Exam solution
Ongoing user support	Carrying out the exam		It support

Activity	Service	Comment	Exam solution or support system
Special adaptation	Attendance		Exam solution and other systems
Logging and monitoring	Carrying out the exam		It support
Report suspected cheating	Attendance	Accompanying documentation from the exam system, proctor etc. Triggers external handling of cheating case.	Support systems

Table B.7: Relationship between activities, services and carrying out

Note that in Table B.7, Green = the same workflow as today, Blue = a new workflow as a consequence of digital case flow, Red = automated workflow, and Yellow = changed the workflow as a consequence of digitalisation.

Part IV: Grading

B.8 Grading: Information model

The following chart describes the activities identified in Appendix A for the grading phase, placed in the context of the information model described in Section B2.

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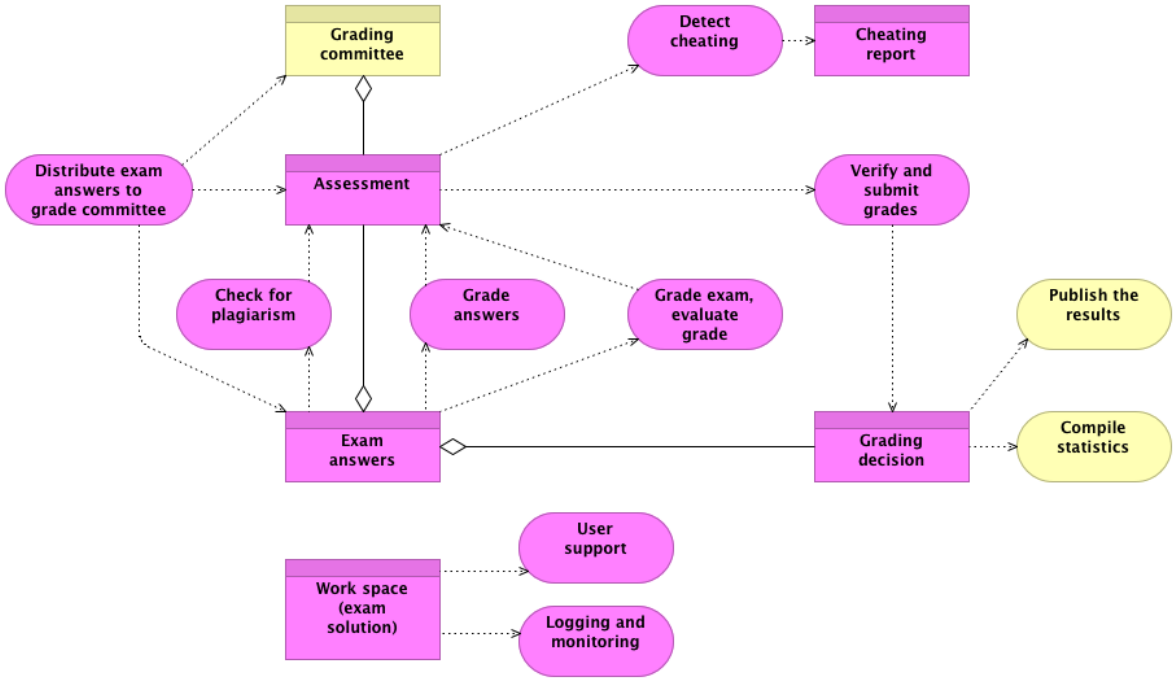

Figure B.7: Activities identified in Appendix A for the grading phase

If the examinee files a complaint, a reassessment will take place. These processes belong in the finalising phase, but follow the same information model and process description as the grading phase.

B.9 Table of activities and services, grading

The grading phase has two associated services: Committee and Individual Assessment. Either type of work is being done on an individual assessment for an exam, or there are processes tied to the committee work. The details are documented in the following table. The table shows the relationship between the services discussed in Section B3 and the activities documented in Section A10. The color-coding is the same:

- Green: the same workflow as today.
- Blue: new workflow as a consequence of digital case flow.
- Red: automated workflow.
- Yellow: changed workflow as a consequence of digitalisation.

Three changes have been made compared with the workflow charts:

- Communication with the examiners is not automated, but changed, entailing a colour-code change from red to yellow. Some of the communication is automated through the exam solution, but communication in connection with the grading meeting is not wholly automated, as there is a need for human judgment.
- The examiner's authentication/login has been added as a separate activity, as it requires communication with an external login service (either ID-porten or Feide).

- Reporting suspected cheating has been distinguished as a separate activity, to ensure a divide between casework and indications from various sources to be assessed. The grading process is usually carried out without change, even when cheating is suspected.

Activity	Service	Comment	Exam solution or support system
Distribute exam answers (answer papers) to the grading committee	Grading committee	Automated	Exam solution
Transfer grading protocol (to examination office)	Grading committee	Automated	Exam solution
Compile statistics	Grading committee	Automated	Support system
Publish the result	Individual assessment	Automated. Extent and integration needs are uncertain.	Support system
Check for plagiarism	Individual assessment	See Report cheating	
Grade answer papers	Individual assessment		Exam solution
Grading exam, evaluate grade	Individual assessment	Often done in grading committee meeting	Exam solution
Detect cheating	Individual assessment	Plagiarism checker	Support system
Communication with examiners	Grading committee	Cannot be red, requires an examiners' meeting as an activity	Exam solution
Verify and submit grade	Grading committee		Exam solution
Sign the grading protocol	Grading committee	Automated	Exam solution
Check the grade	Grading committee	Automated	Support system
Logging and monitoring	Grading committee	Cheating and/or operational requirements	Exam solution
User support (ongoing)	Grading committee		It support
Login	Grading committee	Access control for workspaces, ID-porten or Feide	Support system
Report cheating	Individual assessment		Support system

Table B.8: Relationship between activities, services and grading

Note that in Table B.8, Green = the same workflow as today, Blue = a new workflow as a consequence of digital case flow, Red = automated workflow and Yellow = changed the workflow as a consequence of digitalisation.

Part V: Finalising

B.10 Finalising: Information model

For practical reasons, the information model for the finalising phase has been divided into two:

- Explanations, complaints and tidying up after the exam
- Archiving and storing exam-related information

The following charts describe the activities identified in Appendix A for the finalising phase, connected with the information model described in Section B2.

B.10.1 Explanations, complaints and tidying up

After the exam is carried out and graded, a number of processes need to be finalised. The examinees are entitled to an explanation, on request, for the assessment made during grading. In the case of complaint, a reassessment of the grade shall be carried out. Grading is only final after the expiry of the deadline for complaints.

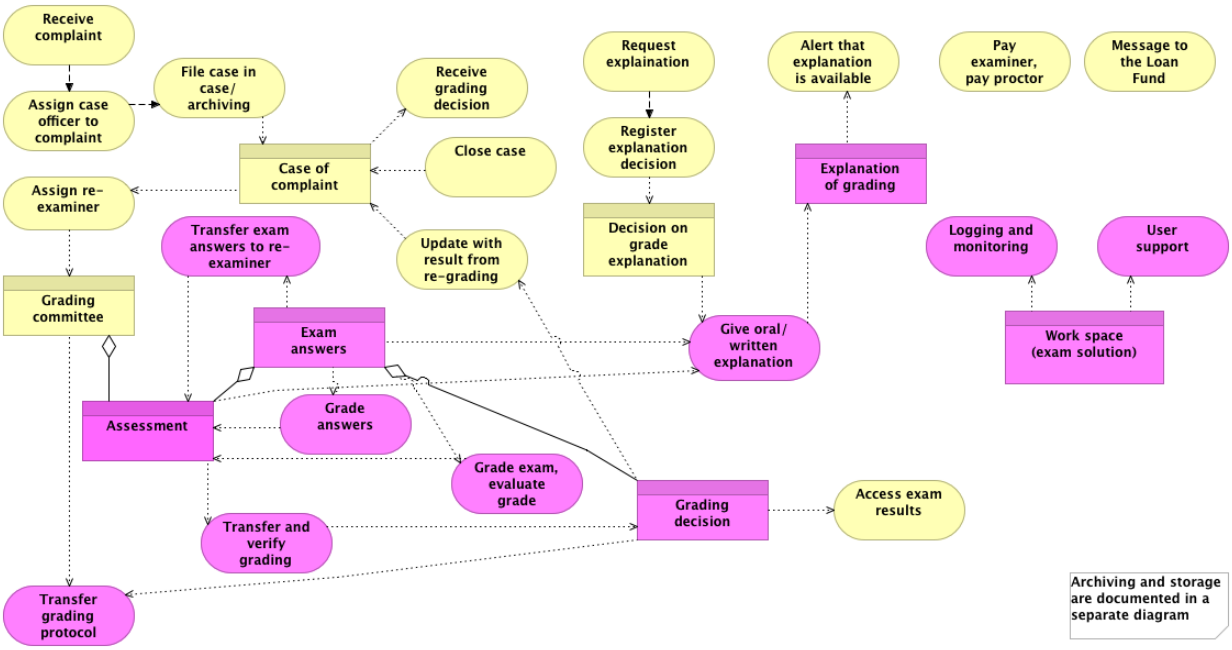

Figure B.8: Final post-exam processes

B.10.2 Archiving and storage

Archiving and storage take place in accordance with the requirements described in the Legal Report, and with a distinction between materials of archival value and other elements that need to be stored.

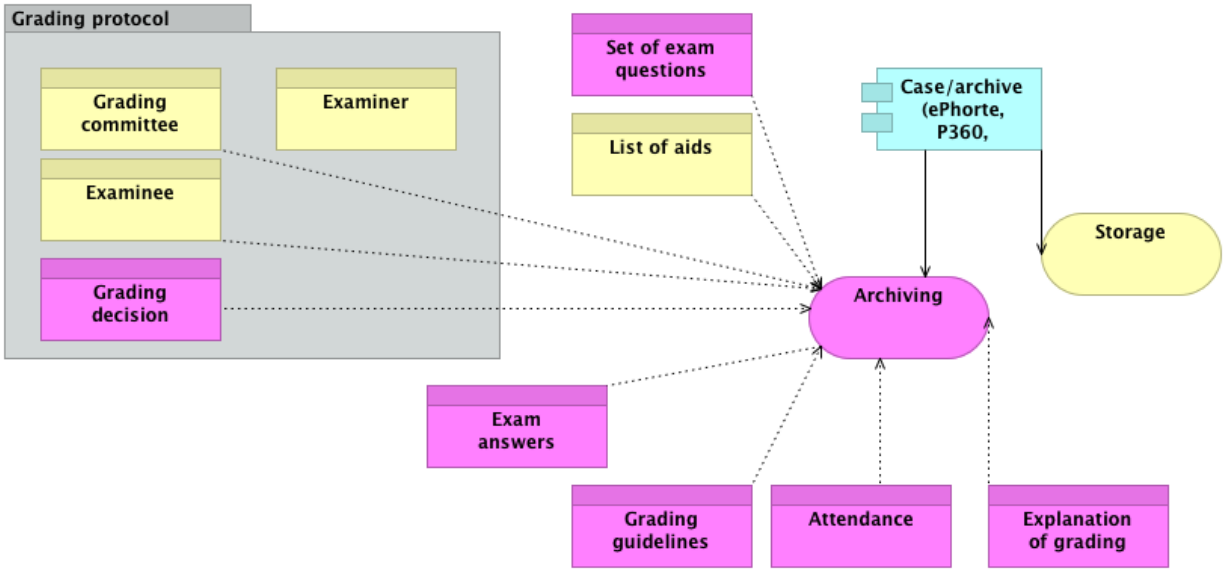

Figure B.9:Archival and storage elements

The two most commonly used archive applications in the HE sector are ePhorte and Public360, while DSpace is used for archiving answer papers with archiving requirements (master's and doctoral theses).

B.11 Table of activities and services, finalising

The table shows the relationship between services discussed in Section B3 and the activities documented in Section A10. The color-coding is the same:

- Green: the same workflow as today
- Blue: new workflow as a consequence of digital case flow
- Red: automated workflow
- Yellow: changed workflow as a consequence of digitalisationigitalisation

Three changes have been made compared to the workflow charts, all tied to reassessment:

- Communication with examiners is not automated, but changed, entailing a colour-code change from red to yellow. Some of the communication is automated through the exam solution, but communication in connection with the grading meeting is not wholly automated, as there is a need for human judgment.
- The examiner's authentication/login has been added as a separate activity, as it requires communication with an external login service (either ID-porten or Feide)
- Reporting suspected cheating has been distinguished as a separate activity, to ensure a divide between casework and indications from various sources to be assessed by the examiner.

Activity	Service	Comment	Exam solution or support system
Get access to the result	Individual assessment	Student portal, self service.	Support system
Request explanation	Request an explanation for the grade		Support system
File complaint	Complaint over grade	Student portal	Support system
Receive grading decision	Complaint over grade	Student portal	Support system
Pay the examiner, proctor		Gets info from the exam solution, is an administration task	Support system
Message the Loan Fund about the grading decision for the examinee		Automated, done from FS	Support system
Register (store, archive) explanation decision	Request for an explanation for the grade	Automated	Exam solution

Activity	Service	Comment	Exam solution or support system
Receive complaint	Complaint over grade	Automated	Support system
Assign a case officer to complaint case	Complaint over grade		Support system
File the case in case/archive system	Complaint over grade	Automated	Support system
Set up new examiners (re-assessment committee)	Complaint over grade		Support system
Distribute answer papers to the examiner	Grading committee	Automated	Exam solution
Compile statistics		Automated	Support system
Publish the result		Automated. Extent and integration needs are uncertain, hence yellow.	Support system
Update case with the result of the new grading.	Complaint over grade		Support system
Archiving		Automated	Support system
Close case	Complaint over grade	Automated	Support system
Storage of exam questions, grading protocol and answer paper		Automated	Support system
Give a written or oral explanation	Request for explanation for grade	A wide array of solutions is used; the examiner needs access to the examination system; issue a receipt if the case is closed	
Alert exam staffer that an explanation has been given	Request for an explanation for the grade	Automated	Support system
Check for plagiarism, discover cheating	Individual assessment	Input to report on cheating from text-similarity report	Plagiarism checker

Activity	Service	Comment	Exam solution or support system
Correct the answer paper	Individual assessment		Exam solution
Grade the exam	Individual assessment		Exam solution
Discover cheating/plagiarism	Individual assessment	Plagiarism checker	
Communication with examiners	Grading committee	Cannot be red, requires an examiner's meeting as activity	Exam solution
Verify and submit grade	Grading committee		Exam solution
Sign grading protocol	Grading committee	Automated	Exam solution
Check grade		Automated	Support system
Login	Grading committee	Feide integration. Access control for the workspace	Exam solution
Report cheating	Individual assessment		Support system
Logging and monitoring	Request for an explanation for a grade, Committee, Complaint over a grade		Exam solution
User support (ongoing)	Request for an explanation for grade, Committee, Complaint over a grade		IT support

Table B.9: Relationship between activities, services and finalising

Note that in Table B.9, Green = the same workflow as today, Blue = a new workflow as a consequence of digital case flow, Red = automated workflow and Yellow = changed the workflow as a consequence of digitalisation.

Part VI: The way forward

B.12 Further work on integrations

A separate working group on integrations will continue work on concretising further work based on this document. Here we document the overall guidelines for their work; for details, see the integration specification.

More work is needed on the detailed specification of integration interfaces. A working group under the auspices of the eCampus project on digital exams is to specify interfaces based on practical experience from local projects and the documentation in this document.

B.12.1 Choice of standards: The IMS family

The IMS standards family [7] is taken as the basis for future work on imaging the information model down to exchange formats. IMS Global develops open standards for learning objects and processes connected to teaching. Common Cartridge offers a standard presentation form for the learning objects of a course, and support for modular web-based adapted learning objects, including assessment. Learning Information Service (LIS) is a standard for describing persons, groups, roles, courses and individual assessments. OneRoster is a proposal tied to LIS for a subset of the information in LIS, and does not quite cover the needs of digital exams. We nevertheless recommend that the integration group take a closer look at OneRoster, since it uses REST-based technologies as a foundation.

For the exchange of diplomas, the student registry FS today uses NS-EN15981:2011 with the ELMO exchange format; here, the relevance to digital exams should be assessed. We otherwise wish to use IMS standards as far as possible for information flow. This is particularly important for integration with a bank of exam questions and other places where digital learning resources flow.

B.12.2 Interface for integration

In connection with solution trials, a joint integration point has been set up between FS and digital exam solutions. This interface currently does not comply with the IMS standards, but is a home-grown REST interface. Even though prototyping based on REST is simple, such a solution requires extensive administration and documentation work over time. It is the assessment of the working group that standardised solutions should be preferred.

We recommend further work on specifications, practical use and trials of more solutions and more interfaces than what has been done so far. We recommend that the further work on integrations be based on the IMS standard.

B.13 Further work

The specification for the common procurement of a digital exam solution will be based on this reference architecture, as well as requirements documented in other best practice documents:

- Infrastructure requirements (UFS145)
- Client-equipment requirements (UFS147)
- Integration requirements (in progress)

This work has considered overall models for some information elements and roles that recur in many different applications and processes, but the information elements presented in this work are limited to digital assessment. To avoid the duplication of information and needless variation in the information elements, the models presented here should be related to the overall information elements that are common to all the processes in the HE sector. ICT systems require unique identifiers for all persons in the HE sector. Identity is therefore often handled in the context of a Person information object. Persons in the sector have some main roles (student, employee – both academic and administrative, external candidate, and the generic item "associate"). To interact efficiently and exchange information, one should standardise these definitions of roles, common information tied to the roles, and the use of authoritative sources for this information. For person-related information on roles, with digital assessment we have seen challenges tied to the definitions of both students and examiners, and to the re-use of these across the sector.

- A student is defined as an active student, student, PhD student, examinee (candidate), external candidate etc. In this document, we have used the role Examinee, which masks the underlying complexity. Work should be done on coordinating how the notion of a student is to be used in different IT systems.
- Regarding examiners, practices vary as to how much information is registered with the institutions. Our starting point is that the person's registered national identification number may be used as a unique ID in connection with ID-porten. As the examiner is paid, foreign citizens will also require a national identification number.

It remains to define how the 'examinee' and 'examiner' in the reference architecture relate to common information objects such as 'student', 'lecturer' and 'associate'.

A number of overarching issues that fall outside the mandate of the working group have turned up in the discussion, and we have missed a clear definition of ownership for common ICT-architecture issues, e.g. an architecture council for the HE sector. In order to profit from common ICT solutions, either data or processes need to be coordinated, or work must be done on the specification of interfaces. The lack of a common anchor point for these discussions makes it challenging to work out a shared understanding.

References

[1] Legal Report ("Digital vurdering og eksamen – en juridisk vurdering"), Spring 2014, https://www.uninett.no/digitaleksamen/rapport-om-juridiske-utfordringer-juni-2014

[2] Reference catalogue for IT standards in the public sector, http://standard.difi.no

[3] Felles IKT-arkitekturprinsipper for universitets- og høgskolesektoren (Common ICT architecture principles for the HE sector), Bergh-Hoff et al, Fall 2014, https://www.uninett.no/arkitektur

[4] Archimate from The Open Group, http://www.opengroup.org/subjectareas/enterprise/archimate

[5] Archi software http://www.archimatetool.com/

[6] Reference architecture models for digital exams https://www.uninett.no/digitaleksamen

[7] IMS Global Learning Consortium http://www.imsglobal.org/

Glossary

CBP	Campus Best Practice http://services.geant.net/cbp/Knowledge_Base/Pages/Home.aspx
Difi	Agency for Public Management and eGovernment https://www.difi.no/om-difi/about-difi
FS	Felles studentsystem (the Common Student Registration System) http://www.fellesstudentsystem.no/
ID-porten	A common log-in solution, operated by Norwegian Agency for Public Management and eGovernment (Difi) http://eid.difi.no/en/id-porten
IMS	(the Instructional Management System) IMS Global Learning Consortium is a member organisation developing interoperability standards for learning http://www.imsglobal.org/aboutims.html