

# Final report

## Modernisation of student information systems Feasibility study

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## FOREWORD

This project was triggered by the challenging state of student information systems in Finnish universities. The widely used Oodi system suffers from obsolete technology and difficulties related to suppliers. Meanwhile, the demands for more efficient university processes, self-service and mobile use continue to increase in all user groups. The present state makes it considerably more difficult to achieve these objectives. Calls for closer monitoring and supervision of studies are also voiced more frequently in relation to, for example, the joint application portal and the new funding criteria of the Ministry of Education and Culture. All this contributes to great pressures for change.

The problem detected in the project is not new. The OPI subproject, launched in 2008 as a part of the RAKETTI project - a development project focused on information management, sought to find a solution to these very same challenges. It resulted in numerous ideas and documents, but failed to produce a concrete plan for the implementation of a new core system.

There is no time to lose. This feasibility study identified a number of clear-cut paths forward. It was conducted by a small team, with members from the University of Helsinki, the University of Tampere and Aalto University, thus ensuring swift progress as well as a sufficient scope of results. Practical implementation will probably involve the same team to ensure efficient activities. The goal is to apply, where appropriate, the valuable results from other education sector projects (e.g., RAKETTI and TIPTOP) and make the final results accessible to all universities.

It will not be easy to decide on the solutions. The key choice will be made between in-house software and off-the-shelf software adapted to needs. While in-house software development will most likely incur lower costs (an estimated €10 million) it involves greater risks and places the responsibility for future operations on the universities themselves. Off-the-shelf software, in turn, is more expensive: the cost for similar implementations in other countries has ranged from €13 million to €24 million. Of late, Universities have mainly opted for off-the-shelf software solutions.

Universities are at different stages in developing their academic administration. In addition to a student information system, what we need is a well-planned transition for individual universities. This involves challenges, but also offers a great opportunity to divide the work into phases and to determine the appropriate focal areas.

This feasibility study provides a solid foundation for difficult future decisions and implementation projects. I wish to thank the whole project team for its excellent work and impressive results.

Pekka Kähköpuro

Chairman of the steering group for the feasibility study of the modernisation of student information systems

## 1 KEY RESULTS

The student information systems currently in use at the University of Helsinki, Aalto University and University of Tampere (Oodi and Opsu) have reached the final stage of their life cycle. The universities' joint feasibility study identified alternative solutions for system modernisation. The goal is to provide universities with a technologically modern system that supports processes related to teaching, studies and academic administration.

### Approaches to modernisation

	A) In-house software development, joint project organisation	B) Off-the-shelf software procurement, joint procurement organisation	C) Off-the-shelf software procurement and in-house software development as parallel projects	D) Renewal of the technology and organisation model of Oodi	E) Autonomous activities, informal cooperation
<b>Investment cost/student (FTE)</b>	€120 4 years	€260–480 4 years	Procurement: €200–300/2.5 years, in-house development: €60–130/3 years	No estimate	No estimate
<b>Opportunities</b>	Cooperation, modern technology, best result in terms of functionality	Cooperation, good result in terms of functionality	Good result in terms of functionality, distributed risk, rapid schedule	No conversion; funding base partly in place, provided the developer universities make a contribution	Solutions for individual universities
<b>Risks</b>	Great risk involved in decision-making and competence	High investment cost, technology update required for key off-the-shelf systems	Interoperability issues, potentially high costs	Failure in software development; only fixes to the present state, no major renewal	No advantages from cooperation

In all the above alternatives, any investment entails redirecting current operations and requires universities to prepare themselves for considerable additional costs in 2013–2016, and possibly longer. The costs presented above are estimates and do not include the universities' own work on specifications. The cost/student (FTE) in alternative C depends on the size of the procurement and the number of universities funding the software development.

### Recommendations

In the project team's opinion, A or C is the best alternative in view of cooperation, rapid time-to-production of functionality and overall results.

Alternative A is best suited to the Finnish university sector because it enables collaborative implementation of the best functional result using modern technologies. However, the universities currently have no clear vision of the supervision, decision-making and common operating models needed in extensive software development.

The advantages of alternative C are a swift start and the risks being distributed across two projects. Off-the-shelf software provides the register's core functionality, but the main components of electronic services for teachers and students can be implemented in-house as in alternative A. The risk in this approach relates to the integration of in-house software development and an off-the-shelf package into a system that serves Finnish universities.

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The recommended alternatives enable:

- cooperation between universities and the accumulation of competence
- reconsideration of processes and replacement of manual administrative tasks with electronic functions plus ensuing cost savings
- notably better electronic services for students and teachers
- a modern electronic learning environment, including mobile interfaces and interoperable systems.

## 2 INTRODUCTION

The core student information system serves as a foundation for all the applications that support the education sector's processes. The feasibility study jointly conducted by the University of Helsinki, Aalto University and University of Tampere offers alternative solutions for modernising the student information systems currently in use. It analyses the present and target states of the participants' systems, examines student information systems available on the market, looks into various university organisation models as well as describes functional and technological requirements and their costs.

This introductory chapter focuses on the background for the feasibility study and the present state of information system development in Finland. The present-state analysis takes a closer look at the state of and development plans for the student information systems used at the University of Helsinki, Aalto University and University of Tampere. It also describes the results of the market survey carried out. The report concludes with a description of five alternative solutions to the modernisation of student information systems. The report also includes appendices whose content is described in the table of contents and in connection with each appendix. Getting acquainted with Appendix 1, describing academic administration processes, may make the report easier to follow. The JHS public administration recommendations *Defining development areas* and *Feasibility study* as well as the enterprise architecture model were applied in the preparation of this report and its appendices.

I wish to thank everyone involved in the project as well as the experts who commented on the work.

### Student information systems in Finnish universities

The Oodi Consortium, in charge of administering and developing the Oodi academic information system, is the nationally most significant organisation in the field of student information system development. The development of the Oodi system was launched in 1995 as a collaborative effort involving the University of Helsinki, Helsinki School of Economics, Helsinki University of Technology, University of Oulu and Sibelius Academy. The system in its current form was first introduced in 1999–2000. The Consortium now comprises 10 universities with a total of some 70,000 students (FTE). This corresponds to 60% of all university students in Finland (FTE in 2011: 113,918).<sup>1</sup> The development and administration of the Oodi system is centralised in the Oodi development unit, operating at CSC – IT Centre for Science. The Oodi Consortium has purchased Oodi development services from CSC since 2010. The Consortium comprises the following universities:

- Aalto University
- University of Helsinki
- University of Eastern Finland
- University of Lapland
- Lappeenranta University of Technology
- University of Oulu
- Sibelius Academy
- Hanken School of Economics
- Theatre Academy Helsinki
- University of Vaasa.

Other universities mainly use systems developed in-house: Opsi/NettiOpsi at the University of Tampere as well as the University of Turku, Korppi/Jore at the University of Jyväskylä, OPREK at the Tampere University of Technology, Minplan/Sture at Åbo Akademi University, Kuti/Kopsu at the Finnish Academy of Fine Arts and SAP (to be introduced) at the National Defence University. Many universities of applied sciences use Winha, which is similar to Oodi in terms of technology.

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<sup>1</sup> The FTE figures were obtained from the *Vipunen* reporting service of the Ministry of Education and Culture and the National Board of Education. The number of FTE students at universities in 2011: Aalto: 12,781, Helsinki: 23,761, Eastern Finland: 10,310, Lapland: 3,437, Lappeenranta: 3,373, Oulu: 10 445, Sibelius Academy: 921, Hanken: 1,632, Theatre Academy: 296, Vaasa: 3 396, Tampere: 10,214, Turku: 12 762, Jyväskylä: 9 687, Tampere University of Technology: 6,472, Åbo Akademi: 4,208, Academy of Fine Arts: 225, the National Defence University figure not available, estimated at 2,000. Total FTE for Helsinki, Aalto and Tampere: ca. 47,000.



## State of information system development

A decade ago, the development of student information systems was carried out in numerous places. The Oodi Consortium worked on its own system, Oodi, whose development unit operated at the University of Helsinki. The Finnish Virtual University handled activities related to virtual studies and the JOO flexible study rights application system, while CSC provided services related to user authentication, and the University of Tampere and the University of Turku developed their own student information system known as Opsu. The Finnish National Board of Education created a joint online application system launched in 2008.

At the end of the 2000s, the Ministry of Education and Culture detected a need to renew the student information systems as well as an opportunity for closer cooperation. Several studies were conducted in 2007–2008, the most important of which, from the universities' perspective, were *Yliopistojen opintohallinnon tietojärjestelmäselvitys* (Hautakangas, Saarinen 2007) and *Opintohallinnon tietojärjestelmäselvitys 2008* (Stigell, Auvinen, Sormunen 2008).<sup>2</sup> The former recommended that universities create a common basic system which would phase out all their technologically outdated basic systems. The latter found that academic administration processes did not prevent universities from engaging in closer cooperation for the purpose of developing student information systems. It also found that the time was right for expanding information system cooperation to encompass all universities.

These studies paved the way for RAKETTI, a development project focused on information management, launched by the Ministry of Education and Culture and higher education institutions. Coordinated by CSC, the project was to run from 2008 to 2014 and was divided into four subprojects focusing on:

- supporting work on enterprise architecture in higher education institutions
- implementing information system services to support students and studies in accordance with a jointly specified architecture
- creating common terminology for research and research administration support services
- implementing a national data warehouse for higher education institutions and data flows involving various authorities

The objective of the second subproject (RAKETTI-OPI) was to create a common information system solution for all higher education institutions (ca. 40). This objective was pursued in 2010–2011, but the resources allocated to the preparation of requirements specifications were insufficient (final report by the data and technology group). Surprisingly, the initial enthusiasm did not go far: the universities offered little input into joint work, and the differences between research-oriented universities and universities of applied sciences proved too great.

The new Universities Act, which took effect at the beginning of 2010, led to the detachment of universities from the state budget and a change in their legal status. The University of Helsinki and the University of Tampere became corporations under public law, and Aalto University became a foundation under private law. Universities were given financial and administrative autonomy, with the state continuing to provide core funding. As the financial situation deteriorated, the Finnish Virtual University closed in 2010, the administration of the JOO flexible study rights application system was transferred to CSC, and Oodi development services and maintenance of the centralised open university search portal were relocated to CSC.

Yet the consequences of granting universities more decision-making power and autonomy did not end here. As determined in spring 2012, higher education institutions will select their own information systems in the future.<sup>3</sup> This will lead to changes especially in the RAKETTI project, which will redefine its focus to support actions taken by higher education institutions and the Ministry of Education and Culture in order to improve

<sup>2</sup> The surveys describe the development and functionality of student information systems as well as similarities and differences between processes in research-oriented universities and universities of applied sciences, which is why they are not described in greater detail in this document.

<sup>3</sup> *Korkeakoululaitoksen tietohallinnon kehittäminen: tiedon yhteismitallisuus ja järjestelmien yhteentoimivuus*, memorandum, Ministry of Education and Culture, 24 April 2012

the comparability of data and interoperability of information systems.<sup>4</sup> In short, the national student information system will not be developed under the coordination of the Ministry of Education and Culture or CSC.

While waiting for a common student information system, the Oodi universities have invested insufficiently in developing their core system, even though the Oodi Consortium has repeatedly pointed out the need for reforms in the 2000s. The Oodi development unit drew up a modernisation plan for Oodi back in 2008, but it was never implemented for several reasons, including the universities' passivity, as well as the Consortium's and CSC's lacking risk management skills and ability to react to real risks in a timely manner. Furthermore, no supplier is currently in charge of Oodi's maintenance and development. CSC, which provides Oodi development services, has arranged a competitive bidding for new suppliers, but they will be unable to launch development until late 2012 at the earliest.

Owing to stronger university autonomy and the present state of Oodi, universities must assume responsibility for modernising the student information system. The University of Helsinki, Aalto University and University of Tampere have an excellent opportunity to jointly solve the issue by creating a modern information system that enables universities to offer their students and teachers a cutting-edge electronic learning environment and to considerably enhance electronic support for administrative processes.

Now that the roles of universities and the Ministry of Education and Culture have been clarified, CSC will play an increasingly important role in ensuring nationwide comparability of data and in creating a centralised data warehouse. Despite its change of focus, the RAKETTI project is likely to remain a key cooperation forum for higher education institutions.

## Other information system projects

CSC will set up a *national data warehouse for higher education institutions (Virta)* by 2014. The warehouse will support the authorities in collecting information about, for example, performance indicators. The data warehouse will also enable information transfer in the joint services of higher education institutions.<sup>5</sup> The centralised application and admissions system used by both research-oriented universities and universities of applied sciences is another important common information system. Slated for introduction during the summer 2014 admissions, the system will require information systems related to university application and admissions services to be coordinated with the national joint application system. For example, the planning of teaching and the recording of educational offerings must be harmonised to enable the information to be transferred to a centralised education portal. Current plans suggest that the interface between student information systems and admissions systems will be implemented using the national data warehouse for higher education institutions and the *register for verified learning* that serves the entire education sector.

The TIPTOP project, focused on information-based support for students' study paths, is a key project related to the modernisation of student information systems. TIPTOP is an ESF-funded project involving several research-oriented universities and universities of applied sciences. Its services help learners to commit to and progress in their studies and to complete their degree. The University of Tampere is one of the implementers, while the University of Helsinki participates in matters related to standardisation and concepts. The University of Jyväskylä has launched the ROTI project, which is related to TIPTOP and aims to develop administrative functionality. The Metropolia University of Applied Sciences has renewed its system used to plan teaching (Peppi) in cooperation with the Tampere University of Applied Sciences and carries out related further development as a part of the TIPTOP project. The software solutions and other materials produced in TIPTOP will be made available to all with an open-source licence. They can thus serve in the modernisation

<sup>4</sup> RAKETTI-hankkeen tavoitteita suunnattu uudelleen korkeakoulujen tietohallinnon kehittämismuistion linjausten mukaisiksi, bulletin, RAKETTI project, 14 May 2012

<sup>5</sup> Korkeakoululaitoksen tietohallinnon kehittäminen: tiedon yhteismitallisuus ja järjestelmien yhteentoimivuus, memorandum, Ministry of Education and Culture, 24 April 2012: The purpose of the new data warehouse is to make the information in university registers reliably and efficiently accessible especially to the student admissions register, but also to the authorities collecting information, to any other national services as well to universities' mutual and own services in accordance with legislation on personal data and the protection of privacy.

of student information systems and in the universities' software development. The project will also expand the terminology and information model of higher education institutions.

From the perspective of the Finnish higher education sector, the internationally most interesting in-house software development project is underway in Sweden, where the national student information system, Ladok, is being upgraded in the Ladok3 project. In contrast to Finland, Sweden has adopted a course-based education system, which integrates basic and continuing education. Moreover, national cooperation in the development of the Ladok system dates back to the 1970s. Over the years, the Ministry has played various roles in steering information system development. These days the Ministry steers activities mainly through educational policy and by specifying the required information. Higher education institutions stand for the costs of Ladok3 and define its content.

To ensure that the information collection of the Ministry of Education and Culture and the universities' information system projects will all work together, a great deal of concept definition has been carried out at the national level. The definition of concepts for the new data warehouse (XDW) and work on the warehouse information model, carried out in connection with the RAKETTI project, are the most important examples of these efforts. The XDW definitions will serve as the basis for the authority data warehouse.

In addition to national and international information system development, social changes, interest group activities, the Bologna process implementation in universities as well as universities' strategic objectives, internal changes and the guidance of the Ministry of Education and Culture's performance negotiations influence work on student information systems. Although it is impossible to describe every element of the operating environment in this report, the analysis of the present state briefly deals with the universities' existing strategies and the current status of each university's information system.

### 3 ANALYSIS OF THE PRESENT STATE AND SUMMARY OF THE MARKET SURVEY

Summary of the present-state analysis

- The University of Helsinki and Aalto University use Oodi, jointly developed by the Oodi Consortium, while the University of Tampere uses Opsu, developed in-house.
- Administrative processes can be made more flexible, provided that the information systems support them.
- The functionality of existing student information systems covers the majority of processes.
- The existing interface system for students and teachers is somewhat confusing.
- Oodi contains a few advanced functionalities, such as the personal study plan and students' self-service functions.
- Oodi lacks features for managing work queues and electronic transactions.
- The administrative functions in Oodi have a high learning curve, making the system more challenging to introduce to new users.
- Oodi and Opsu are outdated in terms of technology.

All parties are ready to cooperate and jointly produce a solution suitable to a broad range of users. Universities want to determine the targets for their own activities involving academic administration and support for teaching and studies in particular. As for the administrative user interface, however, they are more willing to engage in cooperation regarding both the processes and the interface. Renewal of the information system renewal may generate considerable added benefits in the form of working hours saved, if the renewal speeds up processes in academic administration.

#### Present state of systems

As described in the introduction, the national operating environment has changed, and universities must now take responsibility for their own operational information systems.

The University of Helsinki and Aalto University use the Oodi system, developed in the 1990s, while the University of Tampere relies on its in-house Opsu system. Both have two interfaces: the web-based WebOodi and the WinOodi administrative interface in Oodi and, correspondingly, NettiOpsu and Opsu in Opsu. The systems support a wide spectrum of functions and matters related to academic administration: student information, university enrolment, registration for the academic year, study rights, degree structures and the instruction on offer, course registration, completed courses, study modules and degrees, student feedback, preparation of personal study plans, monitoring of study progress (including the legislation restricting study times) as well as student – and partly teacher – activities related to all these. The survey focused primarily on Oodi due to its widespread use in different universities and the complex management structure of the Oodi Consortium.

#### *Technological status*

Several surveys carried out in recent years have pointed out the obsolescence of Oodi. From a technological perspective, the most important of these is Mikael Gueck's 2007 survey, commissioned by the Oodi Consortium, which analyses the source code using technological tools. The survey found that:

- Oodi has a complex and inconsistent technological architecture.
- The same functionality has been implemented in different parts of the application (WebOodi modules, OodiApi, WinOodi), making maintenance and further development expensive.
- The Oodi source code is written in Finnish, which limits software developers to Finnish-speakers.
- Most of Oodi has been implemented in the Uniface and PL/SQL languages, both of which are product-specific and rarely studied by software developers today.
- The Java used in Oodi is mostly procedural rather than modern object-oriented coding.

- The greatest return on investment could be achieved by overhauling Oodi and starting off with a clean slate in terms of both technology and functionality.

The *Oodi baseline* report published by the Aalto University IT architect team in autumn 2011 described Oodi as being at the end of its life cycle due to its outdated technology and the architectural solutions in its applications.

An information security audit commissioned by the University of Helsinki in spring 2012 detected several development areas in Oodi.

To summarise, Oodi is a system at the end of its life cycle in need of a full renewal of its technological architecture. Opsu's technology also needs to be modernised.

#### *Functional status*

The feasibility study explored the views of system administrators and users concerning current development needs in the fields of functionality, technology and the service production model.

WebOodi user surveys were submitted to students at the University of Helsinki and Aalto University. Students at both universities find it easy to enrol in courses and examinations as well as to review their completed studies. Search functions, in turn, are insufficient and lack logic. Around half the students use the personal study plan function, and many said it was difficult to use. Students believe WebOodi should support study planning better throughout their studies.

The staff's opinions were collected through interviews. The Oodi interfaces (WinOodi and WebOodi) were characterised as being outdated and illogical. The system consists of individual modules that do not support users' workflow. Electronic support is offered for only a few academic administration processes (such as the recognition of previous studies and the creation of study modules). Tasks could be made much easier by providing all-encompassing electronic support and automating work phases. The interviewees pointed out that it is possible to enter faulty information in Oodi, since the application only notifies the user of errors, but does not prevent errors from being input. The University of Helsinki has, in fact, created numerous separate database queries that search for errors in Oodi after data entry. The results are used to manually correct the errors. Experienced users have learned to use Oodi efficiently and are quite satisfied with it. Respondents, however, found the system difficult to learn because it is not intuitive and does not support learning. After sufficient practice, however, the tasks became relatively effortless. According to the teachers interviewed, Oodi is very awkward to use. The inconsistent practices of faculties and universities were identified in both staff interviews and student surveys in the two universities.

Surveys show that students at the University of Tampere are fairly satisfied with the system's basic services (e.g., enrolment in courses and examinations). Improvements are needed mainly in services related to study planning.

Enquiries and interviews indicate that the usability of student information systems could be notably improved. The main weaknesses in Oodi's functionality are its interface, high learning curve and lack of workflow support. The problem with Opsu is its lack of support for study planning. The usability of information systems, the availability of electronic tools for study planning and the ease of course searches all have an impact on study progress.<sup>6</sup> When defining the target state for processes (BPI, business process improvement), it is important to collect information on processes and their development goals from users, people in charge of academic affairs and other interest groups as well as to define the target states jointly with all parties.

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<sup>6</sup> Hailikari, Telle, Sjöblom, Anniina: *Opiskelijoiden opintoja hidastavia ja edistäviä tekijöitä*, Faculty of Arts, University of Helsinki, 2012

### *Organisation and maintenance status*

The Oodi Consortium's organisation model is one of the reasons why the system was not technologically upgraded or renewed to support user processes. The universities' confidence in the software development carried out by the Consortium has waned in recent years. One of the reasons is the teachers' interface, which has been under development since 2006 but has never been seen in production and can therefore be deemed a failure. The renewal of administrative functionality, launched in 2010, has never been implemented, partly because consortium fees have remained the same. The transfer of Consortium activities from the University of Helsinki to CSC in 2010 has had no impact on system development or cooperation. University-led steering in the Oodi Consortium in its current form is unsatisfactory, and the deterioration in system administration resulting from problems in supplier cooperation pose special risks.

The overall maintenance expenses (for three parties) are currently estimated at €1.5 million a year. The direct Oodi Consortium expenses of Aalto University and the University of Helsinki are approximately €300,000 a year. Other expenses arise from Oodi user support and software development purchased from suppliers. The expenses of the University of Tampere arise from the maintenance and development of the system currently in use.

### **The strategic framework of universities**

The strategic plan of the University of Helsinki identifies Aalto University as one of its main partners. The University of Helsinki aims to develop a world-class research and teaching infrastructure as well as information systems that support operations. It also seeks to enhance the online visibility of its teaching. Students will be supported in study planning to ensure that they graduate according to the target schedule. A shared administrative information system will be devised to support the University's operations, help to streamline practices and enable cooperation between universities. Special attention will be given to the compatibility and usability of information systems.

In its strategic development plan, from January 2012, Aalto University states its intention to build strong partnerships in research and education with other research and art universities in Finland and internationally. It also highlights its long-term cooperation with the University of Helsinki. Aalto University is an international and multicultural learning community, which provides research, education and academic leadership with high-quality, accessible and efficient services and support systems. Flexible, customer-oriented services enable the academic staff to focus more time on the University's core duties.

In its strategy for 2010–2015, the University of Tampere points out the increasing importance of cooperation with strategic partners, interest groups and alumni. The University aims to reform its administrative structure, degree programmes and research education by the end of 2012, in addition to which it will provide more opportunities for research and internationalisation. The number of study programmes with separate admissions procedures will be reduced and reshaped into broad, strategically motivated programmes. Moreover, student intake will be reduced to guarantee more time for teaching and to ensure that a significantly larger number of students complete their degrees within the target schedule.

The Ministry of Education and Culture will initiate reforms in the university funding model in 2013. In the proposed model, educational criteria will account for 41% of funding and will consist of the following: second-cycle degrees (15%), first-cycle degrees (9%), the number of students completing a minimum of 55 credits (11%, of which 3% is based on student feedback from 2015 onward), credits completed as open university and non-degree studies (2%), the number of second-cycle degrees awarded to international students (1%), international student exchange (2%) and the number of job-holding graduates (1%). Universities Finland (UNIFI) has set up a working group to prepare a new student feedback system for universities (YOPALA). In spring 2012, the Ministry of Education and Culture and the universities held negotiations for the period 2013–2016.

### **State of information system development**

This section describes the present state of information system development at universities as well as future plans in the field.

Aalto University has worked hard to define the information system functionality of its education sector, focusing on the interface between administrative staff and students as well as on the interface between teachers and students. The idea is for the former to link study guidance and academic administration, while the latter forms a comprehensive learning environment featuring functions from both the Noppa course portal and current learning environments.

The University of Helsinki, in turn, is primarily seeking the resources needed to replace Oodi, after which the target state can be specified so the future solution supports teachers and students as well as possible – and more extensively than Oodi – in teaching-related communication and the distribution of learning material.

At the University of Tampere, educational reform has put pressure on development. The examination of education as a whole – including fee-based continuing education – has brought up the need to improve the interoperability of systems, especially those involving financial administration and human resources. Opsu also requires changes stemming from the education reform, which will have students continue from broad-based first-cycle programmes to second-cycle studies. The University of Tampere has decided to implement the services required for the reform by adopting a service-oriented-architecture (SOA) approach based on common specifications and standards. Some of the services will be developed in the TIPTOP project. In the short term, development work will also call for changes in Opsu. The primary objective of modernising the student information system is to support short-term development needs and enhance the competence needed for future solutions. In the long term, the idea is to introduce a broader service entity, which will gradually replace the basic academic administration functionality currently supported by Opsu.

#### *Objectives of information system development*

Aalto University	University of Helsinki	University of Tampere
<ul style="list-style-type: none"> <li>• Aalto University already has an extensive infrastructure outside Oodi (Noppa course portal, Into portal, eAge: electronic transactions).</li> <li>• The tentative vision for 2020 is to create a system that teachers and students can use during teaching (including functionality from Noppa, Moodle and partly Oodi) as well as a system for study planning and guidance, which also has an interface for administrators.</li> <li>• In the joint modernisation project, Aalto is seeking a minimal solution: administrative functions that can be adapted to Aalto's infrastructure and accompanied by applications that match the university's own target processes.</li> <li>• In the early phase (2015), the solution must include teacher-student functionality, which will most likely be replaced should the solution developed in the modernisation project fail to match the envisioned</li> </ul>	<ul style="list-style-type: none"> <li>• The University of Helsinki's information system for teaching and studies is fragmented and lacks a global course portal or desktop for students and teachers.</li> <li>• The goal is to create a consistent and modern system for teaching and studies, which will integrate seamlessly with the University's portal (Flamma) and other systems (e.g., Moodle learning environment, Mobility Online for international exchange).</li> <li>• The University of Helsinki aims to build the foundation for its teaching portal in connection with the modernisation solution. This project is a great opportunity to start afresh.</li> <li>• The suitability of Moodle and other teaching systems to the resulting entity must be evaluated once the target state begins to take form.</li> </ul>	<ul style="list-style-type: none"> <li>• The University of Tampere aims to introduce broad-based services. Some of these will most likely be achieved through projects such as TIPTOP, but modelling is still best carried out in connection with the joint modernisation project, which adopts a more expansive approach, in order to ensure interoperability.</li> <li>• With regard to administrative functionality, the service logic related to the administration of completed studies will be specified in the academic year 2012–2013 jointly with the University of Jyväskylä, with the latter performing most of this work.</li> <li>• The University of Tampere will perform the integration of the service logic and current systems.</li> <li>• The student information system is currently being linked to the integration container (ServiceMix) in connection with the TIPTOP project.</li> <li>• A certain degree of adaptation is to be expected in the user interface layer, since no decision has been made on a particular</li> </ul>

functionality.

user interface technology. Proof-of-concept testing will be conducted to test the feasibility of different alternatives.

Universities generally want to determine the targets for their own activities involving academic administration and especially support for teaching and studies. They also want to specify the functionality and layout of the user interfaces of systems supporting these processes. As regards the administrative user interface, however, universities are more willing to cooperate in both the processes and interface, most likely because process development involves less ambitious plans. The primary objective for the administrative application is to support workflows and make work more efficient; the UI layout is less important.

Despite starting off from different situations, all parties are ready to cooperate and jointly produce a solution suitable for a broad range of users. The information system infrastructure for academic administration, teaching and learning is closely linked to other academic systems. Even if they use the same student information system, the universities will face distinct futures and develop along different paths, which is why the differences in their starting points must be taken into consideration in functional and technological development as well as in system deployment. Once the universities agree on the solution, deployment in each university must be supported by drawing up a plan enabling components of the joint system to be introduced in phases. The system must be designed so that the universities can introduce the modules they want in the same way they currently do in the Oodi system. The model for future development must be constructed in such a way that the universities' different needs can be taken into account while also ensuring that modifications do not risk the maintainability and usability of the core system. The universities do not compete with one another in the technological and functional infrastructure of academic administration: collaboration and sharing are in the best interest of them all. If the parties can agree on a common solution, a separate survey can be launched on the possibility of administering joint software development, for example, by setting up a new company.

## Summary of the market survey

Around 20 off-the-shelf systems and projects were examined during the market survey. System suppliers were approached with requests for information (RFI) to learn about matters related to the technology, functionality, service production and development of systems. Based on the answers to the RFIs, six systems were shortlisted for supplier demonstrations, additional enquiries and visits to European universities where the systems are used. Visits were made to the BI Norwegian Business School (Ellucian Student

Banner), Southampton University (Ellucian Student Banner + other Ellucian modules), Southampton Solent University (Campus IT Quercus 8) and SaNS Expertise Centre / University of Amsterdam (Oracle Peoplesoft Campus Solutions) as well as the holding company of the An Chéim application in Dublin (Ellucian Student Banner). In addition to off-the-shelf systems, there is also an open-source system, Quali Student, developed by North American universities. According to the market survey it is still in the development phase. The market survey results and system features are described in greater detail in a separate appendix.

The survey revealed that there are systems on the market that could most likely be used as the basic student information system in Finnish universities after being tailored and localised for the Finnish operating environment. Off-the-shelf systems cannot be deployed as such. Universities must perform a great deal of customisation and localisation to adapt them to their own processes. The cost estimate, calculated from previous deployments of off-the-shelf systems, is €13–24 million for 50,000 students (FTE). Calculated per student, a joint purchase appears to be more economical than a purchase by a single university. A joint purchase offers cost benefits even if the application is tailored to individual universities. One of the disadvantages of this option is the long duration of deployment. Moreover, it may be years before any advantages are seen after the acquisition.

If the universities set up an organisation to administer the application, the expenses per university will decrease as the number of participating universities increases. However, universities also run the risk of losing staff to a centralised organisation. On the other hand, a centralised organisation may find it difficult to recruit skilled individuals (wages, lack of special expertise)

Based on the market survey, the functional and technological competence required for off-the-shelf systems is best constructed during deployment within the universities or in a joint software administration organisation. This means buying services from the system supplier and, in some cases, from third parties.

## 5 SOLUTION ALTERNATIVES

The feasibility study resulted in five solution alternatives to the modernisation of the student information system. The objectives of the three participating universities have been taken into consideration in all five solutions to ensure that the student information system – whether procured or developed in-house – can be expanded to benefit other universities as well. Before describing the alternatives in greater detail, we will discuss the benefits sought from the investment as well as the risks involved in each alternative.

### Benefits from system investment

The benefits can be divided into three kinds: functional, financial and organisational. They all affect one another: a modernised information system enables the improvement of processes and usability, which in turn saves working hours, while collaborative information system development increases the universities' competence.

#### *Functional benefits*

- Information systems at the end of their life cycle (Oodi, Opsi) are replaced with a new solution featuring better life-cycle administration.
- Work processes are harmonised and the quality of results improves.
- The number of errors decreases and the accuracy of reporting and statistics improves.
- The reliability of registration and reporting increases, helping to secure core funding for education.
- Modern user interfaces and learning environments result in:
  - better experiences among teachers and students
  - guidance that boosts study progress
  - greater visibility of educational offerings
  - an increasingly comprehensive learning environment thanks to interoperable systems
  - the opportunity to link Open University operations to the core student information system
  - improved self-service and mobile options thanks to modern technology.

#### *Financial benefits*

- Savings in working hours, especially at faculties and departments, thanks to improved usability (the current system gets around 5 million annual logins from the three universities)
- Savings in administrative working hours thanks to automated operations and the expansion in self-service options
- Savings in working hours as a result of fewer errors
- Less need for training and support thanks to improved usability and ease of use
- Savings in the hours needed for software development following the adoption of modern technology
- Savings in licence fees thanks to the use of free open source or inexpensive commercial technologies

It is difficult to provide detailed estimates of savings in working hours for such a large project.

#### *Benefits to the universities*

- Deeper cooperation
- Better results and more consistent technological infrastructure thanks to joint input into software development
- The opportunity to centralise system administration, provided that collaboration succeeds and the required conditions prevail
- Clearer ownership steering, improved cost transparency and guarantees of further information system development

## Risks involved in all alternatives

### *General risks related to information systems*

- Management of planning (i.e., software development and scheduling)
- Incorrectly restricted and poorly specified investment
- Lack of commitment and decision-making of management
- Changes in the operating environment and individual organisations (e.g., legislative changes that are difficult to predict)
- Changes in the market and cost savings pressures
- Lack of project skills

### *Identified risks*

- The development stage of organisations and their ability to adopt a solution-oriented approach
- Miscalculated workload and costs
- Evolution of the financial position of universities
- Risks related to the management of staff and competence
- Risk that the project's time span will exceed the duration of software development and funding periods
- Inability to proceed on the basis of a single decision because the number of contracting parties and funding decisions made in different years results in overall decision-making proceeding in phases
- Management's ability to commit to a long-term and high-risk development phase required for collaboration

## Solution alternatives

Owing to the requirements of modern software development, the target states of the universities' work processes must be defined and the information systems must be adapted accordingly in all the solutions presented. However, extensive university-specific customisation of the core functions of off-the-shelf systems complicates system administration and increases both the costs and workload of software development later on. From the perspective of the system's life cycle, expanding operations are more likely to produce financial benefits if the system is developed as a baseline or vanilla version, with uniform core processes, under centralised administration; if its user interface features support for process and workflow specification (including electronic transaction functionality); and if the rules determining the system's behaviour can be defined in the user interface. Fluent decision-making and transparent costs are a must for any joint organisation set up for future software maintenance and development.

The analysis of the present state indicates that the student information system must be modernised – irrespective of the benefits – making this a compulsory investment. Since the student information system is one of the core components that produces information affecting the funding of university operations, this is also a strategic decision. The investment requires universities to prepare for additional costs, at least in 2013–2016 – and probably further into the future. According to the market survey, it will take 2–10 years to procure or develop and deploy the student information system. The investment also requires activities to be refocused on the work and deployment required by the new system. However, since the new system will be easier to use, there will be less need for user support, training, data extraction from the database and other maintenance tasks.

In all the alternative solutions, the Oodi Consortium development unit will support software development and conversion, among other things, by developing Oodi interfaces. In-house development options may enable the use of the University of Tampere's existing competence and current development work for modernisation purposes. In this case, system development cooperation between the University of Tampere and the University of Turku must be taken into account.

The table at the end of this section provides a detailed account of the costs of different alternatives. The planned schedules for alternatives A, B and C are also presented at the end of this section.

## A. In-house software development, joint project organisation

The parties launch an agile project to jointly develop the entire administrative application. They also aim to specify the target states of teacher and student processes to be as similar as possible. However, differences will be taken into account in the user interface so that a UI system corresponding to the development stage of each university's information system can be set up as needed. The first step could involve creating a minimal teacher and student functionality that can be adapted to the parties' user interfaces. This would speed up the transfer to the new system. The project organisation comprises representatives of all the participating universities as well as a software development team. The core team will consist of organisation members and will be strengthened through cooperation with suppliers. The project will produce an application development model that describes how project-external programming elements or ready software components can be linked to the common system. One-sixth or so of the software development team's contribution will be allocated to each university to help them with their own integration and user interface development. This will ensure adherence to a common application architecture and the shareability of results. Software development aims at open solutions as well as optimised licence fees and technological commitments.

The software developers' commitment to the project must be ensured irrespective of market fluctuations. In case software development is unsuccessful, the project can be terminated at the end of a funding cycle, after which another path forward must be chosen.

If successful, project activities can be transferred to the external organisation in charge of system administration. In the long run, it may even be possible to produce a modern student information system for international (European) universities.

A draft schedule and plan for solution A is appended to this document.

### *Content*

- Browsing of education, instruction and degree structures and entry of related data
- Management and browsing of study rights
- Management and browsing of personal and contact information
- Registration for studies and management of registrations
- Management and browsing of completed studies, modules and degrees
- Printouts of student and study information
- Management of code sets and other main user functions
- Possible additional functions include registration for the academic year, personal study plan and electronic implementations of instruction.

The common field will be specified once the target states of processes have been defined. The planning of teaching will be implemented towards the end of the project. As much as possible of the functionality, including the universities' own customisations, will be produced in the centralised organisation.

### *Schedule*

- Autumn 2012: specification of common functionality and the user interface system as well as administrative measures: agreement on the universities' distribution of work, estimated workload, project plan and expectations for the results of software development
- Spring 2013: project launch
- Autumn 2013: first functionality, project termination if the results do not match expectations

- 2014: completion of the first version of the administrative functionality
- 2015: completion of the first full version, Oodi and Opsu disabled, termination of agreements with the Oodi Consortium as planned, commissioned survey of the prerequisites for setting up a company for software administration, decision on the organisation form and potential supplier cooperation in Finland.
- 2016: organisation of activities as agreed; transfer of maintenance, software development and deployment of new functionality to a joint company or other organisation. Organisation of user support at the universities. Launch of service sales to other universities if a joint organisation is set up.

### Expenses

- Estimated development-phase expenses: €120/student (FTE)
- Estimated overall expenses: €6 million
- Estimated annual expenses during the development phase: €1.5 million/year

The results of an agile development project are flexible. The founding costs of the centralised organisation must be added to the overall expenses.

#### Opportunities

- 1. The functional and technical results fulfil the needs, thus ensuring that operations can be supported and improved in the best possible way.**
- 2. A collaboration project enjoys greater resources than a single-university project.**
- 3. The model for centralised software development enables the accumulation of both the universities' and external parties' competence.**
- 4. A modern technological implementation enables the electronic learning environment to be developed and ensures its interoperability with other systems.**
- 5. The system is likely to suit a broad range of users.**

#### Risks

1. Weakness of joint decision-making, which affects software implementation and the establishment of a centralised software administration organisation
2. The complexity of work processes and the difficulty of aligning the operating models of different universities
3. Staff commitment, acquisition and management of competence
4. Wrong choice of technology, which may lead to dependency on an individual and/or supplier, or any other misguided choice (e.g., incompetent supplier or unsatisfactory project organisation)
5. A rise in costs may threaten funding.

## B. Off-the-shelf software procurement, joint procurement organisation

The parties launch a joint procurement project. Each party (the University of Helsinki, Aalto University, University of Tampere) is assigned a suitable entity, which includes administrative functionality and optional student and teacher functionality. All universities will have the opportunity to participate in competitive bidding.

The system licences will be acquired through joint competitive bidding. The parties will jointly define the functionality required by the Finnish operating environment (localisation). The agreement would transfer the responsibility for localisation changes to the supplier, meaning that the supplier would also coordinate change planning. With regard to customisations, some are common to all parties whereas others are university-specific. After procurement, the universities can continue to cooperate or proceed on their own. If the universities decide to continue on their own, they will obtain cost benefits from joint competitive bidding and localisation, but will be able to develop their own customisations after procurement. Should the universities decide to extend their cooperation, they will obtain the benefits described above in addition to synergy benefits in service production and in the further development of functionality as well as in securing the required competence.

A draft schedule and plan for solution B is appended to this document.

## Content

Similar to A, but some of the functionality may be requested as later add-ons.

## Schedule

- Autumn 2012: workshops with the supplier, background work for requirements specifications, agreement on the project organisation (specification/competitive bidding, conversion plan)
- Spring 2013: project launch
- 2013–2014: requirements specifications
- 2014: launch of the competitive bidding process and a separate survey of the prerequisites for setting up a centralised company or other organisation
- 2014: procurement decision, decision to establish a centralised software administration organisation
- 2015: customisation and deployment, pilots, systematic termination of agreements with the Oodi Consortium
- 2015–2016: production use, Oodi and Opsu disabled

## Cost estimates for market-leading software<sup>7</sup>

### Procurement stage

- Estimated overall expenses: €260–480/student (FTE) (excluding hosting services).
- Estimated overall procurement expenses over four years: €13–24 million/50,000 students (FTE)
- Estimated annual expense: €3–6 million

### Maintenance and further development stage

- Maintenance licences: €125,000–600,000/year/50,000 students (FTE)
- Maintenance licences: €2.5–25/student (FTE) (Gartner, market survey)
- Expenses for a centralised organisation for software administration: €1.5–2 million/year for three universities

### Opportunities

- 1. An off-the-shelf system will most likely provide functionality that is in production use elsewhere and immediately ready for use.**
- 2. Off-the-shelf systems may include a great deal of functionality, making it possible to expand their use and to support the entire teaching process (from recruitment to alumni activities).**
- 3. The supplier handles development and technology upgrades of an off-the-shelf system.**
- 4. A joint procurement project enables centralised software management in future.**
- 5. A joint procurement project enables customisation of the off-the-shelf system so that it will most likely suit a wide range of users.**

### Risks

1. The complexity of work processes and the difficulty aligning the operating models of different universities, which lead to a longer requirements specification process and restrictions on the customisability of off-the-shelf systems.
2. The weakness of joint decision-making, which affects software procurement and the establishment of a centralised organisation for software administration
3. The need for technology upgrades: the main off-the-shelf systems will require technological renewal in the near future, the success of which remains to be seen.
4. Staff commitment, acquisition and management of competence
5. Dependence on suppliers, the commitment of key off-the-shelf systems to specific technologies, and the position of Finnish universities in international markets

<sup>7</sup> The estimates are based on actual costs from procurement projects carried out in universities. It is unclear whether these include work performed by the universities. The costs of non-market-leading software may be lower.

## C. Off-the-shelf software procurement and in-house software development as parallel projects

The universities divide their resources across two projects. Aalto launches an off-the-shelf procurement project in which all the universities can participate. One of the main concerns when drawing up the specifications is to ensure that they satisfactorily match the requirements of the Finnish operating environment (localisation) and the needs of other universities. The University of Helsinki and the University of Tampere will therefore actively comment on the requirements. Core functionality and options as well as system localisation and Aalto customisation will be handled separately during procurement. Aalto will listen to the other universities when selecting a competitive bidding approach concerning, for example, piloting. Once Aalto University has made its procurement decision, the other participating universities will negotiate their own agreements and see to the implementation of their customisations. This alternative also makes it possible to later establish a cooperation organisation to maintain the off-the-shelf system and to handle localisation (and perhaps customisations).

The University of Helsinki launches the planning and implementation of the teacher and student functionality in accordance with alternative A. The other universities may commission the software development team to perform work for them and thus ensure the results are compatible with the common software architecture. Agreements on the cost of work will be made separately. In practice, all the universities will continuously carry out software development closely linked to the student information system. To avoid overlapping work, all three universities will work in close cooperation during their development projects. When procuring an off-the-shelf system, special attention must focus on its alignment with the teacher and student functionality developed in-house. If the off-the-shelf system proves unsuitable for the needs of, for example, a multidisciplinary university, the University of Helsinki may also develop the administrative functionality, provided that it succeeds in its software development.

Ultimately, the parties implement or acquire the functionality needed to meet their individual objectives. In this model, the administrative functionality would most likely originate from the off-the-shelf system while other functionality – at least that involving the user interface – would be developed in-house. In both cases, a model must be drawn up for ways to expand the group of users of system components.

Aalto University, the University of Helsinki and the University of Tampere may draw up a cooperation agreement in which the parties give one another access to their results and give the right to comment on the requirements specifications and the specifications for software development.

The most natural approach in this alternative is to launch both procurement and implementation as single-party projects. Each university is in charge of organising its own activities. To ensure the development of the enterprise architecture and the accumulation of competence, the universities and the projects set up must work in close cooperation.

### *Content*

Similar to that of A and B. More detailed specification calls for cooperation between two projects.

### *Procurement project*

The schedule depends on the scope of procurement. The following schedule is for administrative functionality.

- Autumn 2012: workshops with the supplier, background work for requirements specifications
- Spring 2013: project launch, requirements specifications
- Spring 2013: competitive bidding, pilot trials
- 2014: procurement decision, deployment, purchasing option also available to other universities. Renewal of the agreement with the Oodi Consortium, Aalto University terminates the agreement.
- 2014–2015: production use

### *Software development project*

- Autumn 2012: prototypes (technology, user interface)
- Spring 2013: project launch, testing of the user interface system
- Autumn 2013: completion of first full functionality, project termination if the results fail to meet expectations
- 2014–2015: implementation, pilots, deployment
- 2015: completion of the first full version of the system

### *Both projects*

2015: decision on maintenance, which can be assigned to a centralised software administration organisation, in which case service sales to other universities can be launched

### *Cost estimates*

The cost/student (FTE) depends on the size of the procurement and the number of universities funding implementation.

- Estimated procurement expenses: €200–300/student (FTE)
- Estimated software development expenses: €60–130/student (FTE)
- Estimated annual expenses during the development phase: €1 million/year

#### Opportunities

- 1. Smaller dependence on supplier and reduced risks in in-house software development**
- 2. Faster progress thanks to parallel implementation and procurement projects**
- 3. An off-the-shelf system will most likely provide ready-for-use functionality that is in production use elsewhere and serves as a foundation for in-house development.**
- 4. A focus on in-house software development motivates people and facilitates the adoption of modern technology and the creation of an electronic learning environment. The most suitable people can be recruited for supplier cooperation.**
- 5. The model for centralised software development enables the accumulation of both the universities' and external parties' competence.**

#### Risks

1. The weakness of joint decision-making, leading to problems in aligning procurement and software development
2. The complexity of work processes, the difficulty aligning the operating models of different universities and restrictions on the customisability of off-the-shelf systems
3. If Aalto University fails in the requirements specification for the procurement project, the other parties will withdraw from the project and no common off-the-shelf system can be deployed.
4. The distribution of resources across two projects raises costs.
5. All the risks related to alternatives A and B must be taken into account.

Some of the opportunities and risks are the same as those in alternatives A and B.

## **D. Renewal of the technology and organisation model of Oodi**

Oodi's technology will be renewed in a joint Oodi Consortium project or by Aalto University and the University of Helsinki. Work will be initiated through open and solutions-oriented negotiations about the state of the Oodi Consortium, the needs of different parties and the conditions for future development. Talks will also be initiated on the ownership steering of the information system from the perspective of Aalto University and the University of Helsinki.

In practice, renewal means preserving the Oodi database and user interface functionality. WebOodi is coded in Java, WinOodi in Uniface, and part of the functionality is stored in the database in PL/SQL. Descriptions of

the software functionality of WebOodi and WinOodi and the functionality coded in the database will be ordered from the previous supplier. If required, a report on the best technological approach to modernisation will be commissioned from an external consultant. The WebOodi Java application code, WinOodi (Uniface) and PL/SQL database code will be reprogrammed so that the functionality is based on either the Oodi WS interfaces or a redeveloped interface layer. Some of the WebOodi Java code may be preserved (e.g., the personal study plan).

Instead of making major changes to the user interface, the project will analyse which parts to preserve and which to eliminate. It is possible to define the target state for processes and to design the user interface to support them, but in this case alternative A is the more sensible option. If this cooperation model leads to a system that complies with alternative A, a more detailed analysis must be made of the functionality, schedule of implementation and expenses. In this alternative, the University of Tampere will seek solutions based on its own needs.

Decisions on how to arrange maintenance will be made at a later phase.

If the universities do not decide otherwise, this is the path to be followed. The transition phase can be carried out in a controlled manner as described above or section by section in connection with future changes made to Oodi.

#### *Schedule*

- Autumn 2012: analysis of the components to be preserved; database and application descriptions from the previous Oodi supplier
- Spring 2013: launch of implementation project
- Autumn 2013: consultant's report on modernisation and launch of competitive bidding
- Spring 2014: selection of supplier and launch of coding
- Autumn 2016: completion of coding

#### *Costs and organisation of project*

Of the Consortium's annual funding (€700,000), €500,000 will be allocated to new development, in addition to which the universities involved in development agree to contribute €500,000 annually. The project organisation can be located under CSC. Project management and software development competence must be ensured, and the current Oodi operating model must be developed in compliance with the new conditions. CSC and the developer universities are in charge of setting up the development project and acquiring competence, while other Oodi universities have the opportunity to participate in the work. The decision-making model will be renewed to ensure project progress. The Consortium agreements will be renewed. Additional costs will arise from payments for the work performed by the project organisation's project manager, software team and/or supplier. These will amount to a minimum of €1 million annually until the system's basic functionality has been deployed in the Consortium universities.

#### *Opportunities*

- 1. Oodi will get a layered architecture, which will serve as a basis for additional functionality.**
- 3. The workload of conversion is small.**
- 2. There is no need to undo the Oodi Consortium's cooperation model.**
- 4. The solution will likely suit all Oodi Consortium universities, even those that do not actively participate in the project.**

#### *Risks*

1. A long-term project which will not permit the renewal of processes or the user interface; failure is likely (cf. OpeOodi)
2. The solution is probably suitable only for Oodi universities.
3. The old database model and perhaps some of the low-quality software code will remain in use. This will complicate user interface and software development, which in turn prevents renewal of the universities' learning environments.
4. The developers must get acquainted with Oodi's poorly documented and low-quality software code, which increases the workload and weakens motivation.

## E. Autonomous activities, informal cooperation

The universities independently decide how to replace their student information systems (Oodi, Opsu) and how to participate in the future activities of the Oodi Consortium. Aalto University, the University of Helsinki and the University of Tampere may draw up a cooperation agreement in which the parties let one another use their results and comment on the requirements and software development specifications as well as participate in any competitive bidding. The universities may also choose to replace their student information systems in cooperation with universities other than those mentioned here or fully independently and separately. Examples of the latter option include the University of Helsinki implementing the system as its own software development project and Aalto University procuring an off-the-shelf system. Since this option is not based on cooperation, it was not examined in great detail. If this is the approach adopted, each university will be responsible for implementing or procuring the required functionality and for organising the process. Each will also bear the costs incurred.

### Opportunities

- 1. The universities can specify their administrative support and teacher-student functionality independently.**
- 2. The universities can utilise their existing technology infrastructure.**

### Risks

1. The project will not produce widely used software for student information systems or a centralised software administration organisation.
2. The universities must independently modernise their student information systems and solve their funding.
3. The universities must deal with the alignment, integration and reporting of academic administration data on their own.
4. The higher costs for individual universities will compel them to compromise on functionality, and the goals for the modernisation of student information systems will not be achieved.

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## Comparison of solutions

The project team has compared the different alternatives using the following criteria:

- Functional result
- Cooperation, accumulation of competence and expandability of use
- Overall cost of the investment per student (FTE)
- Suitability in terms of the enterprise architecture and architectural principles
- Modern technology and opportunities for future development
- Schedule
- Risks

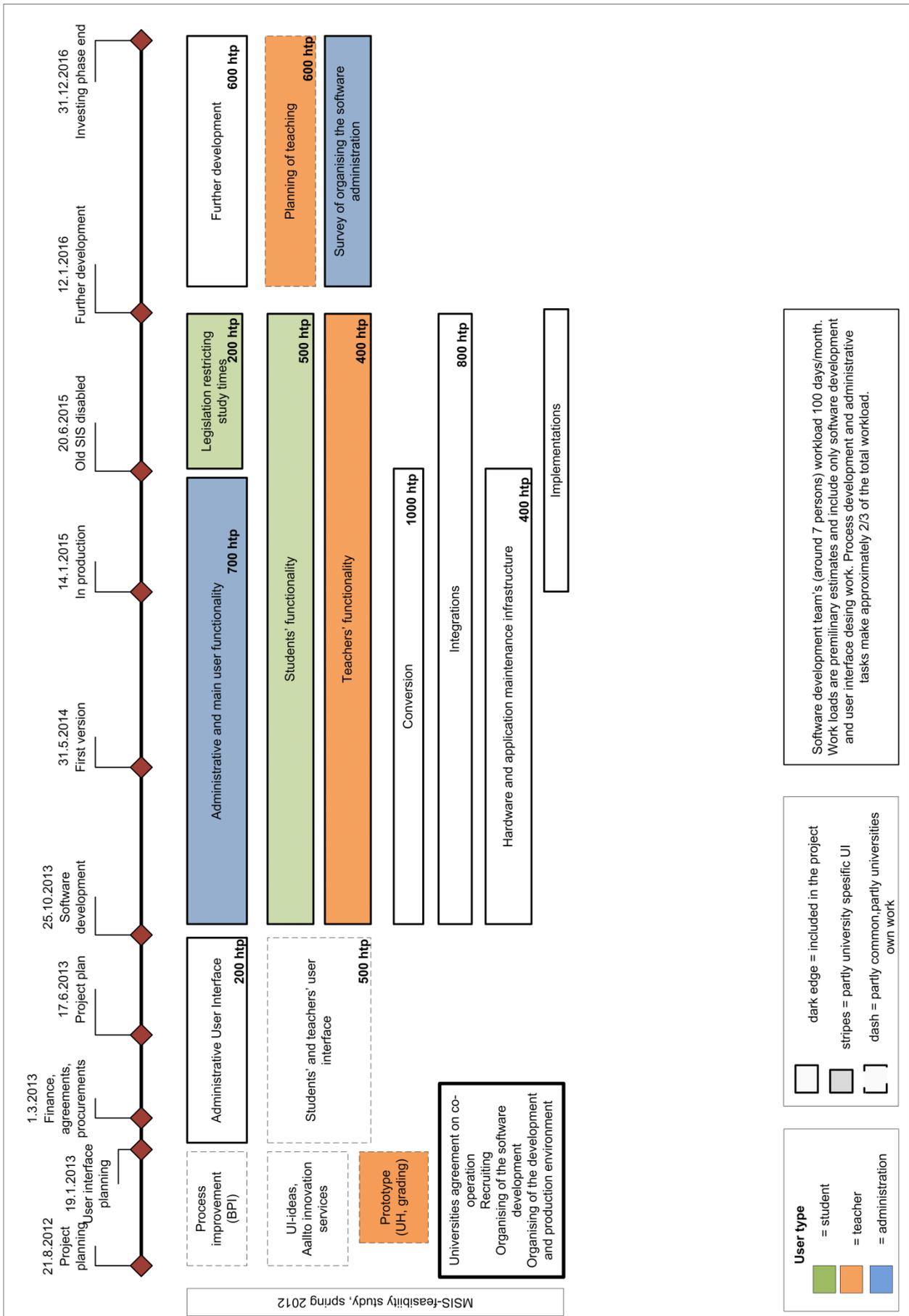
In the project team's opinion, A or C is the best alternative in view of cooperation, rapid time-to-production of functionality and overall results.

## Cost formation of different solutions

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Cost/student (FTE)	€120	€260–480	procurement: €200–300, implementation: €60–130	not calculated	not calculated
Annual costs	€1.5 million/year	€3–6 million/year	procurement: €3 million/year, own implementation: €1 million/year	not calculated	not calculated
Project duration, years	4 years	4 years	procurement: 2.5 years, own implementation: 3 years	not calculated	not calculated
Basis of estimate	Size of project organisation (software development team + administration: 7 + 2 person-years) + external work based on the estimated workload for the implementation project	Known acquisitions of off-the-shelf SIS software and Gartner consultation. The cost structure of acquisitions is not known in every respect. The margin of error of estimates depends on whether the costs include the work process specifications made at the universities.	The cost/student (FTE) depends on the size of the procurement and the number of funding universities. Off-the-shelf system procurement: based on an SIS software acquisition of a size corresponding to that of Aalto University. The costs may be lower if the acquisition is delimited considerably or if the software solutions found are less expensive than those in the market survey. Own software development: Software development team working on the project within the organisation (7+1 person-years) and overall expenses for external work	The costs can be adapted in compliance with alternative A, since most of the funding for today's Oodi Consortium will be channelled into modernisation. The Consortium's larger target group reduces the unit cost calculated in proportion to student numbers.	Each university evaluates its own system costs.
Project management (person-years)	8		4	not calculated	not calculated
Software development (person-years)	28		28	not calculated	not calculated
External work (person-years)	9		2	not calculated	not calculated
Off-the-shelf system licences and related external work (€)	–	€13–24 million	depends on the size of the procurement and FTE figures	–	not calculated
Specification (universities' own work; person-years)	not calculated, no recruiting	not calculated, no recruiting	not calculated, no recruiting	not calculated	not calculated
Testing (universities' own work; person-years)	not calculated, no recruiting	not calculated, no recruiting	not calculated, no recruiting	not calculated	not calculated
Deployment (universities' own work; person-years)	not calculated, no recruiting	not calculated, no recruiting	not calculated, no recruiting	not calculated	not calculated
Conversion (universities' own work; person-years)	not calculated, no recruiting	not calculated, no recruiting	not calculated, no recruiting	not calculated	not calculated

**Implementation timetable, solution alternative A In house development, joint project organisation**

MSS-feasibility study: UH, Aalto, UTA, 6/2012



## GLOSSARY

**Open source** = source code freely available to users

**Baseline or vanilla version** = original, uncustomised version of an information system

**Business rules** = work process specification and other rules

**In-house company** = a company in which the universities' ownership means that no competitive bidding is required

**Integration** = linking systems together, for example, by transferring information

**Administrative functionality** = a system component used by the staff

**Procurement project** = a project leading to the acquisition of an off-the-shelf-system

**Enterprise architecture** = a description of how the organisation's operating processes, information and systems work together as a whole

**Conversion** = migrating information from the old system to the new one

**Customisation** = information system specifications for individual universities or customers

**Localisation** = national/local requirements for information systems, including those based on Finnish legislation.

**Own implementation** = a system developed on one's own (coded in-house or coding purchased from a company)

**Tailoring** = system changes involving either localisation or customisation

**Implementation project** = a project carried out through in-house/purchased software development

**Off-the-shelf system** = a ready product purchased on the market or acquired in another way

**XDW model** = information model for higher education institutions

**RFI** = Request for Information

**SOA** = Service-Oriented Architecture

**SIS** = Student Information System

**FTE** = Full-time equivalent (student)

## APPENDICES TO THE FINAL REPORT

### Appendix 1. Processes

The appendix describes top-level processes in the education sector and provides examples of the target states of some processes. It also outlines the constraints for processes in the education sector as well as the changes expected, which must be taken into account when defining target states. Moreover, the appendix describes the status of work carried out on conceptual and information models in the Finnish higher education sector.

### Appendix 2. Market survey

The appendix describes the market survey conducted in connection with the feasibility study to identify and learn about student information systems available on the market as well as to become acquainted with the procurement and activities both of universities using off-the-shelf systems and of the organisations with which they cooperate. The appendix consists of two parts:

- a) Description of the market survey and its results
- b) Table of the off-the-shelf systems examined.

### Appendix 3. System architecture

The appendix contains:

- Functional development ideas and proposals for their technical solution
- An outline of the universities' information system services in the target state of 2015–2016. The boundaries of the SIS modernisation project are described in as much detail as was possible during the feasibility study. While the functionalities are not described separately, they can be deduced from the process descriptions (in a separate appendix). As for the planning of teaching and studies, registration for the academic year and description of the educational offering, the exact delimitation and stage of implementation will be based on the chosen solution, funding, state of the universities' information systems and external factors (the nationwide application and admissions system in particular must be taken into account).

### Appendix 4. Suitability of solutions in view of the universities' enterprise architecture principles

The feasibility study evaluated the applicability of alternative solutions and that of the present systems to the enterprise architecture principles of the University of Helsinki and Aalto University.



## Written description of academic administration processes

### STUDENT RECRUITMENT

Student recruitment encompasses all the actions that higher education institutions take to attract new students.

### STUDENT APPLICATIONS AND ADMISSIONS

This entity includes the planning of admissions criteria, submission of applications, selection of students and acceptance of a place in a degree programme.

### STUDY RIGHT

The prerequisite for the study right process is that the student has accepted a place in a degree programme. The student can register as an attending student or for the academic year. In this process, a new study right is created or an existing one is modified.

### MONITORING OF STUDY PROGRESS

This comprises statutory monitoring of the target duration set for the completion of degrees and the measures required for monitoring. The process monitors credits accumulated at the university- and unit-level as well as planned studies on which it also provides students with feedback. Information about the courses students intend to complete is used to plan the course offering.

### PLANNING OF TEACHING

This process determines the course offering as well as the degree structures. Student feedback, study-progress monitoring and alumni activities provide useful information for planning. The planning also results in an educational offering used in student recruitment.

### COMMUNICATION ON DEGREES AND INSTRUCTION

This includes distributing information about teaching and course catalogues.

### FUNDING OF STUDIES

Funding includes processes related to tuition fees in the case of students liable to them. It also deals with processes related to financial aid available to students who have been granted the right to pursue a degree in a higher education institution.

### PLANNING OF STUDIES

This process deals with different stages of the personal study plan. The prerequisite for planning is a valid right to pursue a degree. The process consists of students' plans and schedules for completing studies included in the degree. After planning the order of completion, the student enrolls in courses. The planning of studies is also linked to student mobility in the case of students planning to complete studies outside their home university. The planning process is closely linked to counter feedback, completed studies as well as planned studies.

### STUDENT MOBILITY

Student mobility involves processes related to the completion of studies outside the home university.

### TEACHING AND STUDIES

Teaching and studies, encompassing every aspect related to the two fields, require information about instruction as well as students' course enrolments. Teaching receives feedback and produces completed studies. The teaching and studies process involves, for example, various teaching and study methods.

## COMPLETED STUDIES

This process includes activities such as registering completed studies and compiling degrees. Completed studies provide information for monitoring study progress and for ample reporting.

## STUDENT FEEDBACK

Student feedback is obtained from feedback collected in connection with teaching and is used to further develop teaching. Student feedback also encompasses counter-feedback to students.

## GRADUATION

The graduation process includes applying for, preparing and producing the diploma and ensuring that the prerequisites for graduation are met. The graduation process also includes arrangements for the graduation ceremony.

## EMPLOYMENT OF GRADUATES

This process involves career tracking and reporting on the employment of recent graduates. Career and recruitment services monitor the employment of graduates and offer related services and tools.

## ALUMNI ACTIVITIES

Graduates from higher education institutions can participate in alumni activities by joining an alumni association. Association membership is optional and either fee-based or free of charge. Alumni activities include events arranged for alumni, mentoring and career guidance provided by alumni to current and future students, and alumni involvement in planning and providing education in their own field. Higher education institutions aim to boost their visibility by involving alumni in applications and admissions services as well as in general communication services.

**The following processes are related to all or only some of the processes in the process chart.**

## REPORTS AND STATISTICS

This process is linked to several other processes in the chart and yields reports and statistics for different needs for external authorities as well as for internal use in universities.

## COMMUNICATION

Communication is a part of several processes in the chart.

## SUPPORT PROCESSES

Support processes include, for example, management of organisational information, user rights, management of personal information, archiving and integration.

## APPENDIX 2: Market survey of off-the-shelf Student Information Systems in the operating environments of European universities

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### 1 Results in brief

According to the market survey conducted, a number of off-the-shelf information systems on the market could be adopted as the basic student information system in Finnish universities after localisation and any necessary university-specific tailoring. Deployments have proved expensive, and projected costs will rise to €13–24 million per 50,000 FTE students. The survey also identified models in which universities cooperated to deliver centrally-produced IT services in a joint, partly state-funded organisation.

System procurement has required the surveyed universities to specify operating processes, use cases and functionalities as well as to examine options for implementing key work processes in a variety of systems. For off-the-shelf system procurement to succeed, universities must have clear work processes, and organisations must be capable of adapting to a shared operating model subject to the restrictions set by the systems.

The statutory changes required by academic administration can be included in development and maintenance agreements made with the system supplier. Other tailoring needs, however, require university-specific information architectures to be taken into account and necessary specifications to be made. In the universities' experience, the degree of tailoring affects the maintenance workload, meaning that tailored changes to off-the-shelf systems continue to directly impact costs after the procurement and deployment phases. Moreover, the product development phase of information systems has significantly influenced the success of deployment.

The universities surveyed had incorporated technological maintenance competence inside their own organisations – at least at first – or placed system management in a central organisation (SaNS, An Chéim). The cooperation organisations for in-house software development, in turn, have been backed by widespread national collaboration (LADOK, Cineca) in which the state has played a major role, at least in the early phase.

Multilingual functionality calls for a more detailed examination of the user interface and data warehouse in all systems. Translation work must also be taken into account during implementation. Some off-the-shelf systems offer multilingual functionality built into their data models and user interfaces.

The market survey also highlighted other technologically modern alternatives, which merit a more detailed examination.

### 2 Description of the benchmarking process

The survey's goal was to determine whether any of the off-the-shelf systems available on the market satisfy the needs of the universities involved.

As defined in the Finnish Public Administration Recommendations, a market survey examines existing information technology solutions, service ranges and other players' approaches in similar cases. The survey examined some 20 off-the-shelf student information systems as well as other projects developing a similar

system. There are hundreds of student information systems in use around the world. The off-the-shelf systems and reference universities selected for the survey appear in Appendix 2b.

The market survey made use of the international Gartner IT research and advisory company's analyses (Student Information Systems in the North American Higher Education Market, Case study: An Chéim, A Higher Education Shared Service That Works) and consulting services as well as the competence and knowledge of the project's steering group. System suppliers were approached with requests for information (RFIs) about general technological and functional aspects as well as matters related to service production and software development. Based on the answers received and the steering group's instructions, three universities, two software administration organisations and six off-the-shelf systems were selected for more detailed analyses carried out through supplier demonstrations, additional inquiries and, in a few cases, visits to European universities.

Targets of the market survey:

- BI Norwegian Business School (Ellucian Student Banner), Oslo – 20,000 students, six campuses <http://www.bi.edu/>
- Southampton University (Ellucian Student Banner + other Ellucian modules), the UK – 25,000 students, five campuses <http://www.southampton.ac.uk/>
- Southampton Solent University (Campus IT Quercus 8), the UK – 11,000 students, one main campus <http://www.solent.ac.uk/home.aspx>
- SaNS Expertise Centre/University of Amsterdam (UvA), Hogeschool van Amsterdam, University of Applied Sciences (HvA), Leiden University and Tilburg University (Oracle Peoplesoft Campus Solutions), the Netherlands – 110,000 students, four universities <http://www.sans-ec.nl/index-2.html>
- An Chéim – A collaborative service for 14 Irish institutes of technology (Ellucian Student Banner), Dublin – 70,000 students across Ireland <http://www.ancheim.ie/>

Other off-the-shelf systems surveyed:

- SAP Student Lifecycle Management
- SITS Vision
- Jenzabar

The survey also determined the present state of similar projects as well as the opportunities they offered for SIS renewal. The following projects underway were selected for the survey:

- ROTI – renewal of the basic student information system, University of Jyväskylä
- TIPTOP (incl. ROTI, PEPPI), an ESF-funded project involving Finnish universities and focusing on information-based support for students' study paths
- Ongoing development projects involving Finnish universities, universities of applied sciences and the Ministry of Education and Culture: joint electronic application system, centralised education portal, national data warehouse for higher education institutions, register for verified learning
- Ladok3, system development for Swedish higher education institutions
- Quali Student, an open-source system developed by North American universities

The information systems were roughly evaluated in the following fields:

- Software architecture and technology
- Usability and user experiences
- Open or closed source
- Costs, when possible
- Integratability, interfaces, expandability
- Outlook for future system development
- Description and size of the company/community developing the software
- References and service model

- Language versions (database, user interfaces, code)

### 3 Observations on the universities' student information systems and related arrangements

This section describes the selection and deployment practices for off-the-shelf systems adopted by the surveyed universities and centralised organisations, as well as their supplier cooperation and organisation structure.

#### Summary

- *There are applications that can be modified* according to the universities' needs (integration into the learning environment, scope of service processes).
- All the universities mentioned *business rules* as a critical success factor in terms of risk management and a prerequisite for the alignment of operations and information systems.
- Adaptation to the national operating environment and new statutory changes must be recorded in agreements, for example, as an annual activity to be performed by the supplier.
- *The complexity of processes and the ensuing extensive tailoring* complicates further development (deployment of the supplier's system versions) and makes it *expensive* because of the competence-management required.
- *System competence is built into the organisation*, and limited consultation is purchased from consultants others than the system's main supplier.
- *Centralised administration of a system used by several universities is cost-effective if all the universities use the same version and decide to harmonise their academic administration work processes.*

#### Selection of software and supplier

In the final phases of its competitive bidding process in 1996, Oslo Business School considered two offers, one of them a national solution (NS) and the other a commercial one (Banner). Functionality was the deciding aspect (Banner met 60% and NS 40% of the needs estimated at the time) and the final selection was based on the user case method.

At the University of Southampton, the survey group was unable to meet the people involved in the selection phase. At present, however, the goal is to find best of breed solutions, which means acquiring one functionality at a time and integrating each into the learning environment.

In the selection phase in 2004, Southampton Solent University considered Banner too expensive and the data model and technology of SITS/Tribal outdated. It consequently opted for the Irish CampusIT software, which the nearby University of Portsmouth also uses. An Irish supplier was felt to be sufficiently acquainted with the operating environment and close enough for cooperation (Dublin).

The SaNS expertise centre builds on a cooperation agreement signed by four universities in 2001, which led to the launch of a procurement project in 2004 and software selection in 2006. Banner was ultimately deemed too expensive, while the software developed by the Dutch themselves failed to meet the requirements. Oracle's software, however, satisfied the demands: a strong supplier, extensive functionality, support for workflow and a guarantee of development ability. Competitive bidding was arranged on the basis of the universities' joint two-year specification. In the deployment phase, this ultimately led to extensive tailoring, problems related to competence management and miscalculated costs.

In Ireland, institutes of technology launched their system cooperation in the field of quality assurance in the 1990s – in dire economic times, with the Department of Education steering operations in a more cost-effective direction and favouring outsourced services. The goal of system selection was to obtain wide-ranging functionality and market-leading software. As a specifically appointed assessment committee

recommended, the selection was made within the project organisation on the basis of specifications and competitive bidding and by becoming acquainted with systems used in other universities. The Department of Education has from the very beginning borne part of the development costs of the student information system. It has later earmarked budget funds for universities that use An Chéim's services, and the universities, in turn, have transferred the funds to An Chéim to develop and maintain its service provision.

## Software deployment

In many cases, the deployment of off-the-shelf systems has required extensive tailoring and internal development work in universities. All the universities surveyed indicated that to obtain full benefit they had to keep to basic software functionality and seek a balance between the organisation's needs and the information system's features.

All the Banner deployers surveyed (Oslo BI, Southampton University, An Chéim) began the process before the software was fully developed. This resulted in several years of further development and tailoring and, at least at first, required IT competence to be developed within the organisation in order to ensure competent version maintenance. Furthermore, the software has been adapted to widely divergent needs in the university sector, which has called for extensive changes to the baseline version and led to complex software version management.

The market survey indicates that suppliers appear to have provided the universities with a baseline version as well as consultation for systemic software management and database management. However, the universities have had to handle implementation, consequent version upgrades and integration with other learning environment software on their own or as a centralised service. Competence building has been difficult in the beginning. This has been offset by external supplier work, which has sometimes been successful and sometimes expensive and unsuccessful. These Banner deployments were product development projects involving an application originally created for the North American learning environment and subsequently localised for conditions in Norway, the UK and Ireland.

Southampton Solent University practically went from "paper to pen" to brand new software (Quercus, CampusIT), beginning with the deployment of a single module (course manager). It consequently deployed several new functionalities from 2004 to 2012 (a total of 38, eight of which involved statutory changes). In-house development is estimated to have accounted for 10% of overall functionality. New software development is primarily carried out by the supplier. These days, the University first analyses whether a new functionality can be produced using an existing application or its add-in.

Deployments carried out in centralised university organisations involved similar challenges. SaNS deployed software localised for the Dutch university environment, introducing a single baseline version into five different learning environments. In practice this meant performing extensive software tailoring centrally and collaboratively under the auspices of SURF, a national organisation. A road map has since been drawn up for operations, aiming to eliminate tailoring by 2014.

An Chéim has carried out two significant SIS software deployment phases since 1999. The first distributed software management proved unsuccessful, among other things, due to a lack of management skills in small universities. An Chéim later developed a joint tool, "Common Standard Design", which led to a reorganisation of joint software management. Tailoring currently accounts for only 13% of the overall system, compared to 49% in the early phases. All of An Chéim's customers now use the same applications and concepts in the same database and keep the product compliant with the latest common supplier upgrade.

An Chéim has also been criticised in its role as a software developer by Gartner, which pointed out that centralisation has come at the cost of strong control through the standardisation described above. This has occurred despite activities being supported by a national cooperation team and groups organised by operating processes in universities. From the perspective of sustainability, An Chéim today aims to facilitate cooperation between universities, seeks the most efficient and economical way to produce common IT services and secures the product development needed by universities in the form of supplier cooperation

## Supplier cooperation

The examples from the UK and the Netherlands highlight the importance of ensuring through agreements that the supplier implements statutory changes in the baseline version at least once a year. Furthermore, building business cooperation from the beginning requires universities to exhibit a strong and professional approach to international companies as well as results-oriented partnerships with other customer universities.

Universities have benefited from working in close cooperation with the supplier. Oslo BI was a frontrunner in product localisation for Europe and has built up solid business cooperation with the supplier: the University is on the Ellucian Higher Education Steering Committee, participates in supplier activities and conferences, and is committed to development focused on the new-technology beta version of the software. Southampton University has strived to develop national cooperation between universities using the application into a basic functionality of the product. It has also produced special modules catering to national needs. It took years to achieve successful cooperation and good results, and after the most challenging phase of cooperation (the years following implementation), the University has goal-orientedly built up cooperation relationships similar to those described in the Oslo case.

Satisfied with its supplier's development model and testing practices, Southampton Solent cooperates with the supplier to produce new additional modules or functionalities for the baseline version. Pilot deployments, for example, are no longer conducted. Instead, the process moves from the test environment straight to production. Software development is quick and based on requirements as well as a test plan with user cases. Southampton Solent and its supplier have adopted a development platform, WEB Access Environment, for product demonstrations, development tasks and training. In general, agreements are made for a strategic period of five years (the current agreement is valid until 2015) even though the student information system and the needs related to it have a longer life span.

Licence agreements for the Dutch SaNS are made individually for each university. In practice, however, the director of the centralised organisation is in charge of supplier cooperation in line with the decisions of the organisation's board. The director of SaNS is the former IT manager of one of the universities involved and is thus well acquainted with the universities' operating environment. This has been the case from the very beginning.

An Chéim is the development partner of Ellucian, the supplier of Banner, in one of the new-technology modules. Supplier cooperation was also emphasised in Ireland, but, on the other hand, the occasional lack of understanding of the European operating environment was criticised. The supplier's commitment and high-quality consultation are vital to the success of deployment and future product development. This was also evident at BI in Oslo and at the University of Southampton. As a centralised organisation, An Chéim differs from SaNS in that it is centrally responsible for the universities' licence management for both Banner and the required Oracle basic licences.

## Organisational structure

Oslo BI has a strongly centralised internal IT unit consisting of three teams focused on operations, development and support services (35 members in all). Operating on several campuses in several localities, the university provides guidelines and training to users of the academic student information system and mainly uses a software-specific electronic helpdesk function for support.

The University of Southampton has a separate IT unit (iSolutions, 270 employees) as well as a Student and Academic Administration unit (SAA, 350 employees). The SAA consists of several university-level teams handling processes related to different stages of studies. The university's team managers answer for the operations, practices and policies of the process stages assigned to them, while Faculty Education Managers (FEMs) are in charge of the implementation of faculties' work processes. Both Oslo BI and the University of Southampton now arrange development work into projects using best of breed solutions. Both universities are also involved in the development of a new beta Banner.

A small, new university, Southampton Solent appears to have benefited from successful supplier cooperation and an advantageous stage of product development at the time of software deployment. Matters related to the student information system are handled by a team of ten, six to seven of whom work on the Quercus system, allocating approximately two person-years to the work. Although the strategic focus is on deploying self-service activities, teachers do not use the system. Instead, functions concerning entities smaller than a module are handled in the timetabling software and courses are managed in Moodle.

SaNS is a unit of four higher education institutions which operates under SURF, a cooperation organisation similar to CSC in Finland. SURF handles the localised software versions of Oracle PeopleSoft with an input of 13 person-years. Members of the SaNS organisation include a head, a product manager, an office manager, a service desk (2 people), functional application maintenance (3 people), technical application maintenance (3 people), and developers (2 people). The organisation also purchases services from external developers. The work related to software hosting services amounts to six person-years and has been outsourced. The annual expenses of SaNS total €3 million, €1 million of which come from hosting services. The universities have functional teams responsible for user support, in addition to which each university pays for its own software licences.

SaNS is considering incorporating its operations as well as launching service sales in maintenance and further development to new user universities. Owing to higher-than-expected development costs, other universities have not yet joined service activities. To increase revenues, the organisation is also considering not rolling development costs into future service prices to new customers.

An Chéim, a public company in Ireland, is responsible for the broadly centralised system management of 14 small and medium-sized institutes of technology. At least 30% of the work is estimated to target the development and maintenance of the student information system. Other centralised systems include the financial and payroll, library and reporting systems. From an organisational perspective, An Chéim is owned by Dublin Institute of Technology (DIT), Ireland's largest, which, surprisingly, does not use the system in its own operations. Ireland's largest universities (Trinity College Dublin and University College Dublin) are also in charge of their own systems. One of them recently opted for SITS/Tribal, while the other one uses Banner (the same system the institutes of technology use as a service provided by An Chéim).

The An Chéim organisation is led by the Board of Directors, Chief Executive and General Manager. They are supported by a representative body known as Institutes of Technology Ireland (IOTI, Institute Presidents) and IOTI Institute Senior Management Committees (Council of Registrars and Financial Controllers Group). The An Chéim organisation proper has four teams: the Delivery & Operations Management Team; the Relationship Management Team; Finance, Procurement and HR; and Internal operations & Support. During the market survey, An Chéim employed nine people and had outsourced activities such as software management, 24/7 hosting services and technical user support. The organisation started off with 75 employees, reducing its headcount to 45 before implementing its current operating model. The universities using An Chéim's services have always had their own IT units or teams that closely cooperate with the Relationship Management Team.

An Chéim's operations and funding are agreed upon annually. The annual budget of €7.8 million consists of a basic sum (staff costs 10%, software upgrades approximately 20%, as well as outsourced services,). Separate agreements may be made on additional funding for projects. Procurement competence appears to have improved over time, and agreements are now made mainly by the team/unit directors and the manager. Supplier agreements include penalty clauses against failed operations or scheduling. According to An Chéim, 98% of its project implementations adhere to the schedule and 100% adhere to the budget.

## 4 Results for individual information systems

### Corresponding projects and consortia

**ROTI** is the University of Jyväskylä's project set up to renew the basic student information system based on the university's existing system. Thus, it cannot easily serve as a national system.

- The project has proceeded to the implementation stage, the goal being to deploy the system in October 2012.
- The basic register contains information about students, study rights, completed courses and degrees. The project's goal is to implement an administrative user interface based on this information. The current user interface, KORPPI, is to serve as the interface for students and teachers.
- Regarding concepts, the new system will be based on national models and specifications (TIPTOP).
- An open-source system
- Will be produced as an in-house development project. The University of Jyväskylä has its own development team, which has worked on student information systems for several years.
- The technology is the same as that in the TIPTOP project (Java, Spring, ESB).

The ROTI code may be further developed, potentially as a collaborative effort.

**LADOK3, Sweden** is a new-technology development project currently in the feasibility study stage. The goal is to find a comprehensive solution for the Swedish university sector, supported by a solid legislative foundation and an existing system management organisation.

### Kuali Student

- A component of a North American open-source system
- Curriculum management has been implemented, but other components are still under development (next in line are Enrolment and Accounts, with Enrolment including functions such as course enrolment and evaluation).
- Much of version 1.0 is expected to be ready by the end of 2013, and part of the Enrolment module should be ready for use in 2014.
- It is possible to join the Kuali community in exchange for contributing with one's own development input. The source code may also be deployed and further developed without membership in the community.
- Members (i.e., official partners) of the community can have their say in the product's development trends and resources.
- Kuali user interfaces can be tested at <http://kuali.org/test-drives>
- Presentation videos are available at <http://www.youtube.com/user/KualiFoundation>

Based on the presentation videos and materials, the product seems to have potential in terms of technology and (free) open source code.

### The Higher Education Information Systems, HIS, a German information system service

- The organisation was established in 1969 as a non-profit foundation of Volkswagen and was taken over by the German federal and state governments in the 1970s. HIS is a part of the German system of higher education, its task being to support system development and information management needs.
- HISinOne is an extensive system for academic administration. As a whole, the HIS system also includes functions in fields such as finance, personnel management and research.
- The system features modern technology (Java, Spring) and has proved to be a potential alternative in earlier feasibility studies (Ladok, Survey of student information systems 2008). However, the organisation has failed to respond to numerous contact attempts. The Ladok3 project also

discontinued its examination of the system for the same reason. Expansion to other countries apparently does not feature in HIS's strategy and fields of interest.

**CINECA** – an administrative unit for the information systems of Italian universities, founded in the 1980s; a non-profit consortium involving universities, public administration and research units.

- Market share: used in 75% of Italian universities
- KION, a company founded in 1999, is tasked with developing and maintaining the student information system.
- A technology upgrade was launched in 2001, and since 2006 the goal has been to expand into the European market. The company has since sold services to Turkey.
- The steering group of the Finnish modernisation project considered CINECA a suitable object for benchmarking, should incorporation become a topical issue in Finland.

**SIGMA** is a consortium of eight Spanish public universities and is equivalent to Cineca.

- Founded in 1996, with a market share of 17%, SIGMA student Information System is used in 20% of Spanish public universities
- No information about its technological status

## Summary and SWOT analyses of off-the-shelf systems

This section examines off-the-shelf systems which, based on the market survey, most likely support academic administration processes. Many of these systems also support a wide range of processes that assist teaching and studies.

- Most off-the-shelf systems can be easily adapted (source code open to institutions, ready tools, expandable information model), though this is not recommended.
- The systems probably require a great deal of tailoring, unless the users' needs are flexible enough to adapt to the processes in the basic package.
- Some of the systems are very comprehensive, encompassing nearly all education sector processes.
- Some of the systems include features related to workflow specification and queues.
- Self-service for students is a hot topic worldwide; Oodi has been a frontrunner in this respect.
- Some of the systems feature outdated user interfaces, which are now slated for renewal; others have quite modern interfaces.
- All the systems are or will be undergoing technological renewal (source: Gartner, benchmarking). However, benchmarking indicates that some of the systems already feature modern technology (e.g., Jenzabar)
- The University of Helsinki – and possibly Aalto University and the University of Tampere – lag behind reference universities in their use of a centralised integration platform.
- Nearly all systems are under development and their integration capabilities have improved.
- Some of the systems feature strong SOA; others are under development.
- The SOA approach could serve to build user interfaces on top of off-the-shelf systems (e.g., teacher and student functionality, mobile applications).
- The systems often benefit from supplier-coordinated user communities, which provide (mobile) applications and support.
- Suppliers have no experience of the Finnish academic administration, but some of their partners may.

Systems which were incomplete (ROTI, Kualii, Ladok3) or of which a comprehensive understanding could not be formed were excluded from the SWOT analyses. With regard to the project's goals, all the systems roughly feature the desired functions, but more detailed examinations reveal differences in the functions, processes and data. Their applicability, however, must be ensured in separate workshops in cooperation with suppliers.

## 1. Ellucian Student Banner / Lumini / Powercampus

Assessment based on: RFI + visit to BI Oslo + visit to Southampton University

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Largest SIS supplier worldwide</li> <li>• Adaptability (tools, also open source)</li> <li>• Flexible process support</li> <li>• University cooperation, strong and large user community (Commons), which offers access to modules developed by universities</li> <li>• Decent performance</li> <li>• Product actively developed by Ellucian</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Complex database</li> <li>• Old-fashioned implementation of integration at the universities visited (no completed SOA services yet in use)</li> <li>• Banner 8 self-service user interfaces felt outdated</li> <li>• Supplier dependence on many Oracle products</li> <li>• Originally designed for the North American university environment</li> <li>• Potentially expensive licences</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Numerous modules that could be deployed</li> <li>• A possible cooperation partner in Finland (Cerion Solutions)</li> <li>• Upcoming Banner version 9 technology reform (Gartner: duration of entire technology reform ca. 10 years)</li> <li>• Technology reform offers modern user interfaces</li> <li>• Expandability through portal and integration platform functions</li> <li>• The large number of deployments outside the USA (1,000) gives reason to believe the system can be adapted to Finnish university processes</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Ongoing technology reform, no deployments</li> <li>• Inability to achieve a good status with Ellucian (Finland is a small market)</li> <li>• Incorporation of national features into the baseline product (localisation)</li> <li>• Possible need for large personnel resources</li> <li>• The flexibility of the software poses challenges to customisation</li> </ul>

### Technical description

- Conceptual model and Finnish needs for information: according to the RFI, the information model can be expanded virtually using the Supplemental Data Engine, which keeps the core information model unchanged.
- User interfaces: the Self-Service Engine, a tool included in the package, can be used to create individual user interface pages (for displaying information and storing it in the database, downloading files into the database); integrated into Luminis Enterprise, an in-house portal.
- The database is a mixture of relational and object-oriented databases, and, according to the supplier, it is normalised (3NF). The user interface has been designed using the MVC model.
- Software requirements: Oracle Fusion Middleware 11G. Compiler requirements: COBOL, ANSI C, Unix ANSI C or C++, Windows MS Visual Basic C++ 6.0 or later)
- The supplier offers its own Infinity Process Platform (IPP) as the integration broker (APIs, Banner event publishing mechanism, Web services, XML Message objects, batch integration framework). Most of the integrations have been created by the universities themselves (e.g., using BizTalk at the University of Southampton).
- Banner is delivered to customers along with the source code
- SaaS and ASP are possible. Pricing and agreements: based on the number of students; the software licence comes with a maintenance agreement; minimum duration of the agreement three years, maximum ten years
- Over 1,000 customers, ca. 40 consortium customers

## 2. Oracle Peoplesoft Campus Solutions

Assessment based on: RFI + visit to UvA/SaNS + demo

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Strong language support for data and user interfaces</li> <li>• Expandable user interface (application designer) and database</li> <li>• Interfaces, integration options (WS)</li> <li>• Commitment to product development</li> <li>• Database independence (Oracle, SQL Server, DB2)</li> <li>• Good features: workflows, task lists and messaging</li> <li>• Quite extensive functionality</li> <li>• Good information architecture (historical as well as forthcoming data)</li> <li>• Initial and annual licences are moderately priced.</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Usability of the teacher and student user interfaces</li> <li>• The user interfaces are outdated and difficult to use; information about development paths is unavailable.</li> <li>• Poor opportunities to influence the product</li> <li>• High price of implementation if/when localisation and tailoring are needed</li> <li>• Supplier dependence on many Oracle products</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Oracle develops interfaces and SOA</li> <li>• User interfaces can be created on top of interfaces</li> <li>• The large number of deployments outside the USA (1,000) gives reason to believe the system can be adapted to Finnish university processes</li> <li>• SaNS offers ready customisations which may suit Finnish processes</li> <li>• Ongoing technological renewal (Gartner: 5–7 years)?</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Incorporation of national features into the baseline product (localisation)</li> <li>• Possible need for large personnel resources</li> </ul>

### Technical description

- According to the survey conducted in the Ladok3 project:<sup>8</sup>
  - delivery includes the system source code and user interface development tools
  - the system comes with an integration broker
  - limited support for multi-tenancy (the use of a single installation by more than one university)
- The user interface is entirely web-based and can be edited within the system
- The user interface may include several language versions and the language of the student interface can be changed
- Pricing: standard prices \$10–20/licence, initial investment (as indicated in Ladok): €7/FTE student, maintenance fees €1.54/FTE student Ladok is used by some 270,000 students, which translates to an initial investment of approximately SEK 16.7 million and maintenance fees of SEK 3.7 million.

## 3. SAP Student Lifecycle Management

Assessment based on: RFI + demo

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Open source code/In-house changes</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Usability of user interface</li> </ul>
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<sup>8</sup> "The source code to the screens in the system together with development tools are shipped with the systems." "There is a PeopleSoft integration broker installation as part of the system." "There is limited support for running multiple institutions within the same installation. The system is not a perfect multi-tenant solution."

<ul style="list-style-type: none"> <li>are possible</li> <li>Offers a versatile module structure for services</li> <li>Can be integrated into the current environment (SAP) of the University of Helsinki and University of Tampere</li> <li>Processes are adapted to SAP functionality to reduce tailoring</li> </ul>	<ul style="list-style-type: none"> <li>The latest new university customer: Vrije Amsterdam 2010</li> <li>Supplier dependence on SAP products</li> <li>Module-based pricing may be high (Gartner)</li> <li>Inflexible product</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>Strong integration with other SAP architecture (e.g., University of Helsinki, University of Tampere)</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>Organisation and service level of user support</li> <li>The local SAP supplier may be unfamiliar with the student information system product and processes</li> </ul>

### Technical description

- Student Lifecycle Management is a module in SAP ERP.
- SAP's own technology
- Pricing is based on designated users and the packages selected.
- Delivery includes the source code.

### 4. Campus IT Quercus

Assessment based on: demo + visit to Southampton Solent University

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>Visually modern Web user interface (section created with APEX, full transition to APEX in 2014)</li> <li>Web interface already includes most of the functions</li> <li>The supplier's development capacity and cooperation with universities (Solent)</li> <li>Workflow support built into the software</li> <li>Clear information model</li> <li>Good customer support from CampusIT (customer portals, tickets, etc.)</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>Usability of the administrative user interface (implemented using Oracle Forms, to be phased out in 2014)</li> <li>Designed for the UK/Irish university environment</li> <li>Supplier dependence on Oracle products</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>Inexpensive licence fees</li> <li>May offer suitable solutions to open and continuing education needs</li> <li>Medium-sized supplier with possible interest in expansion</li> <li>The supplier's development model is fast and agile</li> <li>Opportunity to expand activities outside the scope of the modernisation of student information systems (graduation processes)</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>Degree of advancement of technological development (APEX?)</li> <li>Data historisation option?</li> <li>Smallest supplier of those studied</li> <li>Unclear whether the product can be tailored to deal with the processes, functions and information of Finnish universities</li> </ul>

### Technical description

- Small Irish supplier

- The first production version was created in the 2000s and has since been actively developed with universities/institutions.
- Nearly exclusively based on Oracle, including the user interfaces
- Ready interfaces (e.g., learning environments, timetabling software, portals, university website), SOA-based, integrations with ESB or messaging (on offer: Oracle ESB)
- Different language versions have not yet been implemented. The supplier has suggested running different user interfaces in parallel as a possible solution to language versions.
- Used mainly in the UK/Irish higher education sector

## 5. SITS Vision

Assessment based on: RFI

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Extensive functionality</li> <li>• Strong player in the UK (used by ca. 70% of the higher education sector)</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Technology of the administrative user interface (Uniface client)</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>•</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Suitability for modernisation</li> </ul>

## Technical description

- Comprehensive responses to RFIs, ca. 70% of the UK university sector
- Widest functionality on paper, appears to be extensively configurable
- Developed using Uniface 8 (current version Uniface 9), can be used through a client or web. Supports most platforms, operating systems, databases (MS-SQL and Oracle mentioned by name) and user interfaces.
- Integrations: dynamic communication Microsoft Biztalk, IBM Websphere, standard XML messages, Web Services (Stu-Talk, e.g., SOAP 1.1). The creation of a RESTful WS-API is under investigation. The interfaces are owned by Tribal and are developed/expanded in cooperation with customers.
- Language support and localisation: localised user interfaces are available through translation tables. SITS:Vision is used by, among others, a Norwegian customer (the education authority of the City of Oslo?) Most of the records contain user-specific fields which may be used to store different language versions.
- Licences are granted for campuses with an unrestricted number of users (students, staff, applicants, sponsors, other interest groups) 20% of licence fees annually for maintenance and development. Licence pricing is based on the selected modules and the university's FTE figure (in increments of 500 students) If, for example., three universities purchase as a joint consortium, pricing is based on the overall FTE figure and the expenses are divided among the three.
- Depending on the customer university, project costs have ranged from £100,000 to £3,000,000. Once the functional requirements have been determined (for the selected modules), Tribal can supply the cost estimate for implementation.

## 6. Jenzabar

Assessment based on: RFI + demo

<p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Relatively modern technology stack (Java EE 6)</li> <li>• Database-independent (according to the supplier, it currently supports four different databases)</li> <li>• Relatively modern user interface (portal)</li> <li>• Fully SOA-based system</li> <li>• Source code open to institutions, own customisation an option</li> </ul>	<p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Full database language support not available for another 18 months or so (character set support available)</li> <li>• Back office user interface (administrative interface) a separate Java client. Fully Web-based by 2014 (roadmap exists)</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Numerous functions for study monitoring and contacts (universities' strategy)</li> <li>• Adaptable portal, enables expansions</li> <li>• The supplier recently made a significant decision to invest \$25 million in further product development.</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• Supplier's commitment to localisation</li> </ul>

### Technical description

- A U.S. company, with customers on ca. 700 campuses; no known installations in Europe
- Relatively modern technology (Java EE 6)
- Good opportunities to develop one's own user interfaces/portals
- Teacher and student functionality through a dedicated portal, separate Java client for officials; functions to be transferred to the portal by 2015
- The source code is delivered to the buyer, the software can be adapted and the data model expanded using available tools
- Full database language support to be available within 18 months
- Based on the demonstration, the product may be a potential option in terms of its technology/architecture (SOA), layout and user interface.

## 7. CAMPUSOnline

- A product developed by the Graz University of Technology (TU Graz).
- No plans to expand operations outside Germany or Austria

## Appendix 3. System architecture

### CONTENTS

- 1 Development ideas and technological solutions
- 2 Charts of information system services
- 3 Technical architecture, summary of meetings
- 4 Technical view of dependencies between data in student information systems
- 5 Examples: database consolidation, open data
- 6 Open data in the student information system

### 1 Development ideas and technical solutions

This chapter describes four development ideas for student information systems and the related functional and technical solutions along with the grounds for them. The following information is provided for each item:

- Idea
- Functional solution
- Technical solution
- Grounds and benefits
- Risks
- Present state
- References

#### Idea 1: Development of electronic services and processes

Most of the functions in the student information system involve electronic transactions and measures related to them. For example, a student enrolls in a seminar, the teacher or computer verifies that the student meets the prerequisites, approves (or rejects) the enrolment and sends the student a notification of approval (or rejection). The student submits the enrolment on a form; the prerequisites for participating in teaching are the rule.

##### Functional solution

The workflows and rules related to electronic transactions are described and the forms created (in the graphical user interface) separately from academic administration functionality. The user's work queue is displayed in the SIS user interface or in a separate user interface. Users see their own work queue and the organisation's queue, can select a task and perform it in the student information system. To obtain full benefit from this solution, the university should acquire a separate system for process and workflow management used throughout the university for both electronic transactions and internal processes.

##### Technical solution

The student information system's rules and process logic are placed in their own module, and information system functionality can be derived directly from the processes (PDA, or Process-Driven Architecture). This does not necessarily mean automatic code generation from process description. The university can procure a separate BPM or BRMS system or use a jointly implemented "process and rule engine". The process logic is implemented mainly as an orchestration, meaning that information system services are unaware of one another and their interaction is instead controlled by a centralised module. Communication between system services is handled by message-oriented middleware (MoM). The rules are stored in a "rule engine".

##### Grounds and benefits

- Faster and more manageable changes to processes and workflows
- Improved management and interoperability of processes between several players, such as units
- Transparent and well documented processes, workflows and rules
- Less administrative work thanks to electronic transactions
- Work queues enable work to be distributed and the turnaround time of measures to be monitored (e.g., registration of completed courses)
- The separation of process and application logic makes programming easier

## Risks

- 1) The programmers' competence is insufficient to separate process description from information system services.
- 2) The university chooses not to deploy a comprehensive BPM solution, thus blocking the achievement of some benefits.
- 3) The deployment of a BPM solution involves a great deal of work, increasing the risk of failure.

## Present state

- Aalto University uses its own eAge system for workflow modelling and form creation. The universities use form applications (e-form, webropol).
- The University of Helsinki and the University of Tampere use no workflow modelling software.
- The rules of Oodi and Opsu are programmed directly into the software code,
- As a rule, Oodi modules do not support workflows.

## References

- BPM and BRMS software is widely used around the world. Suppliers: <http://www.appian.com>, [www.progress.com/](http://www.progress.com/), IBM, SAP...
- Literature:
  - Gartner, Magic Quadrant for Business Process Management Suites 2011
  - Belhajjame, Collet, Vargas-Solar: A Flexible Workflow Model for Process-Oriented Applications. WISE (1) 2001, IEEE CS, 2001.
  - Wikipedia: BPM
  - Forrester report on the ROI of BPM solutions: [Forrester\\_roi\\_of\\_bpm\\_suites.pdf](#)
- Based on interviews, the MoM solution is supported by, for example, MK/Silverplanet, MT/University of Helsinki, TT/Aalto University.
- Code generation from process descriptions is not a feasible solution (BPMN→BPEL) (MK/Silverplanet, TH/Reaktor)

## Idea 2: Uniform user experience and workflow support for teachers and students

### Functional solution

Teachers' and student's functions before and during teaching are placed in a single user interface with links to materials and teaching technology tools. Learning environments and other teaching technology tools continue to be used for two-way communication. The functionality of the user interface is the same in all universities, but its layout can be modified to reflect the visual look of each university. The administrative user interface can be integrated with the user interface or kept separate from it.

### Technical solution

To the extent possible, a common information model, a common technical solution for information system services and a common application programming interface (API). If required, each university can choose its own technology for implementing the user interface. If they all use the same technology, there is less need for programming, making the results easier to share and maintain. Programming and testing account for some 30% of the overall work.

### Grounds and benefits

The workflows of teachers and students can be supported by adopting as many systems that differ as little as possible from each other in terms of function and visual look. Teaching technologies are a part of instruction, and it should be possible to use and vary them in different ways based on the requirements of teaching. A separate administrative user interface may improve the usability of the teacher's and student's user interface.

### Risks

- As a result of separating the teacher's user interface from the administrative one, it may be impossible to run all processes in the same user interface.
- The user interface contains a great deal of functionality at the expense of usability.
- The universities are unable to reach a mutual understanding on functionality.

### Present state

At Aalto University, Oodi provides access to course registration, personal information and completed courses, while Noppa handles communication during the teaching period. Users are very satisfied with Noppa, but it cannot be adopted as such, for example, at the University of Helsinki. The Universities of Helsinki and Tampere have no single system for communication during the teaching period.

### References

- Aalto University Noppa portal: <https://noppa.aalto.fi/>
- Teaching portal and course pages of the Department of Computer Science at the University of Helsinki: <http://www.cs.helsinki.fi/en/studies>

### Idea 3: Open data

Public data related to academic administration is freely available to internal and external players for further processing (editing, merging, filtering and refining) in machine-readable format.

#### Functional solution

Public data related to academic administration (excluding personal information) is available for open use. Anyone can use it to create new applications, such as chart services of teaching.

#### Technical solution

Open and closed data fall into different databases. Public data will be placed behind an open, user-friendly interface. Interface implementation must take into account performance, meaning that, if needed, the load is evened out. Closed data will be placed behind a firewall, and information security must be ensured.

#### Grounds and benefits

- Free distribution of public data would benefit Finnish business and civic activities widely and contribute to the enhancement of administration. [1]
- Data produced with public assets should be made publicly available.
- Could substantially increase the UI offering
- Improves information security: if closed data reside in a separate database, access to it can be protected more efficiently
- Improves performance: no encryption is needed for the database and open data interfaces (encryption and decryption are time-consuming tasks)

#### Risks

- Identifying open data and constructing and maintaining a technical environment to support it require a great deal of work
- Performance comes under threat
- Separate databases for open and closed data make application development more difficult, since data must be synthesised from different databases (e.g., teaching and participants)
- Distributing information about open data increases the workload

### Present state

Most of the open data related to academic administration are currently available in the course catalogue, but in no specific form.

### References

- The European Commission has published a strategy for open data.
- [1] The Ministry of Transport and Communications has published open data guidelines (in Finnish). Further information: [[http://www.suomi.fi/suomifi/tyohuone/yhteiset\\_palvelut/avoin\\_data/](http://www.suomi.fi/suomifi/tyohuone/yhteiset_palvelut/avoin_data/) ]

### Idea 4: Modular and layered technical solution

#### Functional solution

The technical solution aims to support functional needs flexibly so that:

- changes can be transferred quickly to production
- new functions can be developed quickly and easily
- the availability and accuracy of data as well as performance can be improved
- supplier dependency can be avoided
- technologies can be made more upgradable, and the usability of information system functions can be promoted.

#### Technical solution

- Layered and SOA-based application architecture
- The database, application logic, information system service level and user interfaces use the same technology and message representation so messages need no conversion. This facilitates programming, improves maintainability and enhances performance.
- Open data technology: http, JSON message format, REST request format.
- Closed data and internal services: Message transmission in addition to synchronous communication, data transfer from different layers should be as efficient as possible and information system services should be available for versatile use (e.g., AMQP, MessagePack-RPC).
- External interfaces: ESB or any other integration platform used at the university

#### Grounds and benefits

- SOA: The main benefit is that SOA reduces the workload and time required to modify processes and the systems that support them. [2, p. 8]
- Open data technology: Javascript, commonly used in browsers, can handle JSON without conversion, and the HTTP protocol is native to browsers.
- Closed data and internal services:  
Consistent technology improves performance and speeds up programming. The message transmission system enables asynchronous communication and can serve as a coordinating element for information system services.
- Enterprise Service Bus: the ESB solution is apparently a better option in cases where the technology and message format cannot be chosen (off-the-shelf and legacy systems). Interfaces can be administered using a single user interface while information can be sought and external information system services used with relatively little programming work.

#### Risks

- Software developers' competence is insufficient for implementing and maintaining the application architecture
- Direct integrations are favoured over the use of information system services
- No message transmission system or external integration platform is used
- Technologies are not upgraded frequently enough
- Competitive bidding does not require suppliers to adhere to a specific application architecture, but gives them the freedom to specify one
- The risk of failure in SOA projects is quite large due to, for example, the workload required by SOA services and the specification of administrative procedures

#### Present state

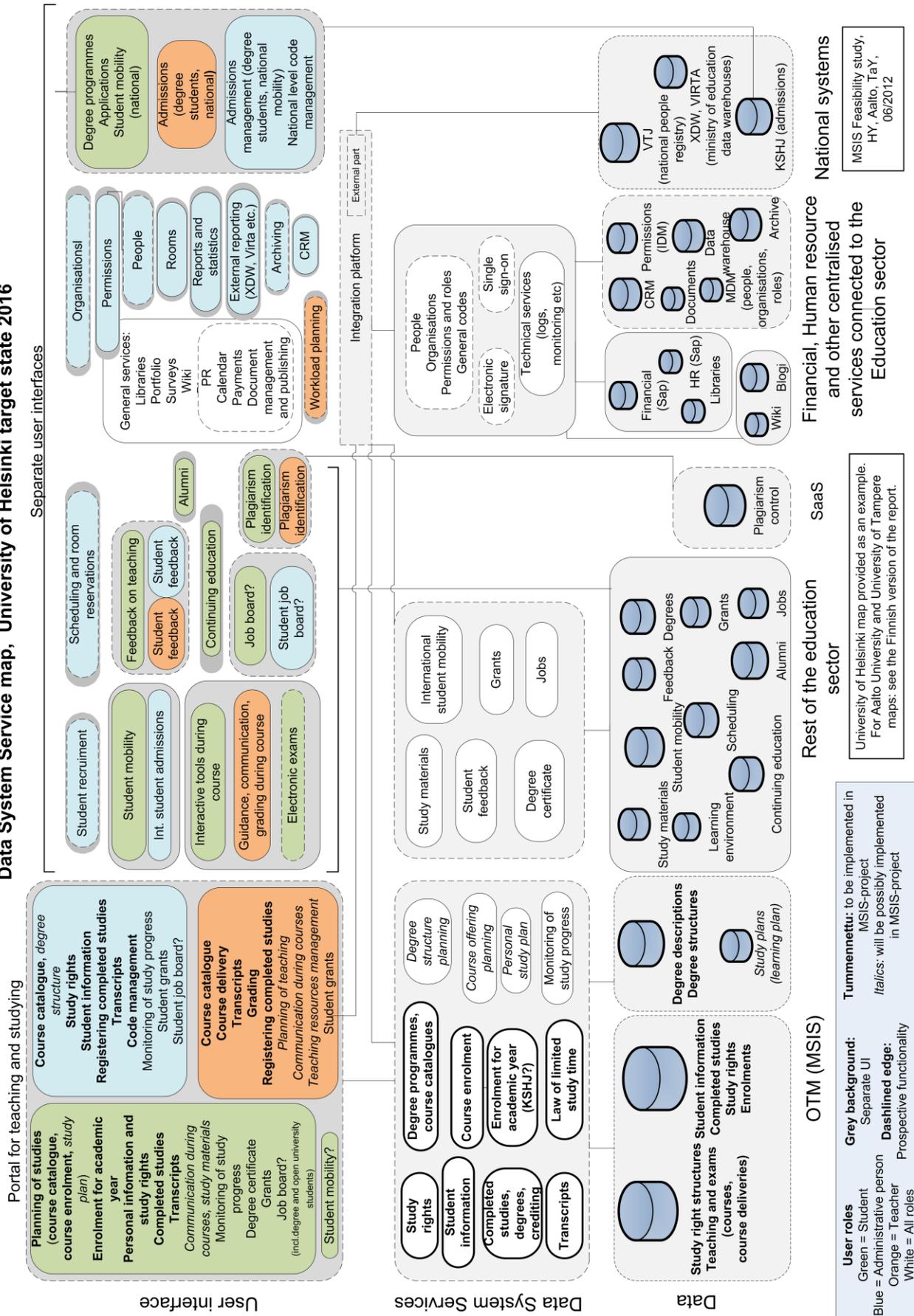
- The University of Tampere has chosen SOA as its development ideology for the student information system
- Aalto University uses AMQP for some integrations
- The University of Helsinki has tested AMQP and the other technologies mentioned. An integration platform survey is under way in both Aalto University and the University of Helsinki

#### References

- SOA is the current trend in software development
- In Finnish academic administration, at least the Metropolia University of Applied Sciences and the Finnish National Board of Education have implemented or plan to implement systems based on SOA.

- 
- [2] Gartner: SOA Overview and Guide to SOA Research, 2011: “While SOA's principles are durable, SOA design practices evolve. Increasingly, SOA projects use business process management (BPM), master data management (MDM), operational business intelligence and event-driven architecture (EDA).”
  - Message-oriented middleware (MoM) is used in performance-critical environments, such as banks and stock exchanges. MoM → EDA.
  - Open data technologies: recommended by TH/Reaktor.
  - Use of the MoM solution is recommended by: MK/Silverplanet, MT/University of Helsinki, TT/Aalto University.

**Data System Service map, University of Helsinki target state 2016**



## Technical view of dependencies between data in student information systems

The data sets in the student information system and their interrelations at the level of databases are listed and described below. The interrelations are also depicted graphically.

### Level 1

- Basic student information
- Courses
- Degree structures; compulsory items: courses
- Study rights; compulsory items: degree structures
- Courses, modules and degrees completed; compulsory items: courses

### Level 2

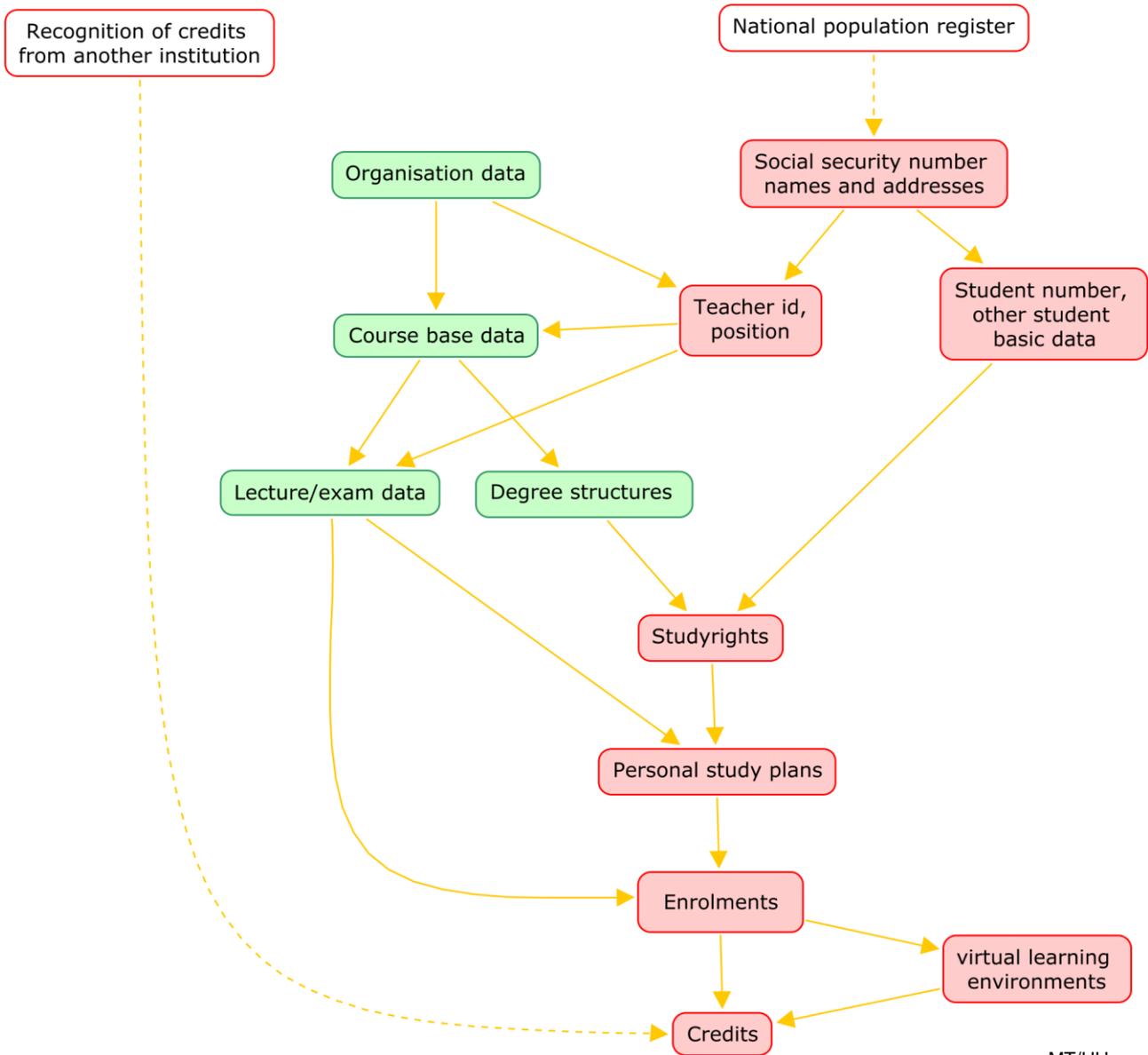
- Implementation of teaching and registrations; compulsory items: courses, students and study rights
- Education and course offering (course catalogues); compulsory items: courses and degree structures

### Level 3

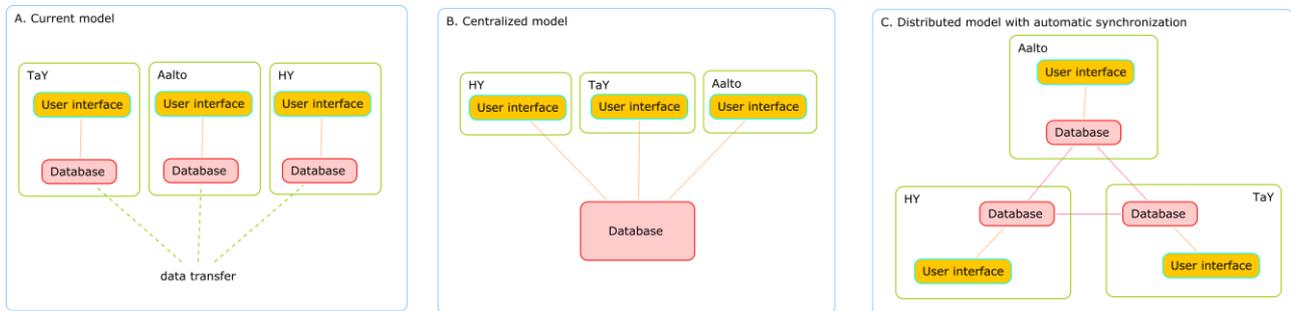
- Personal study plan and study progress monitoring; compulsory items: preceding levels

### Level 4

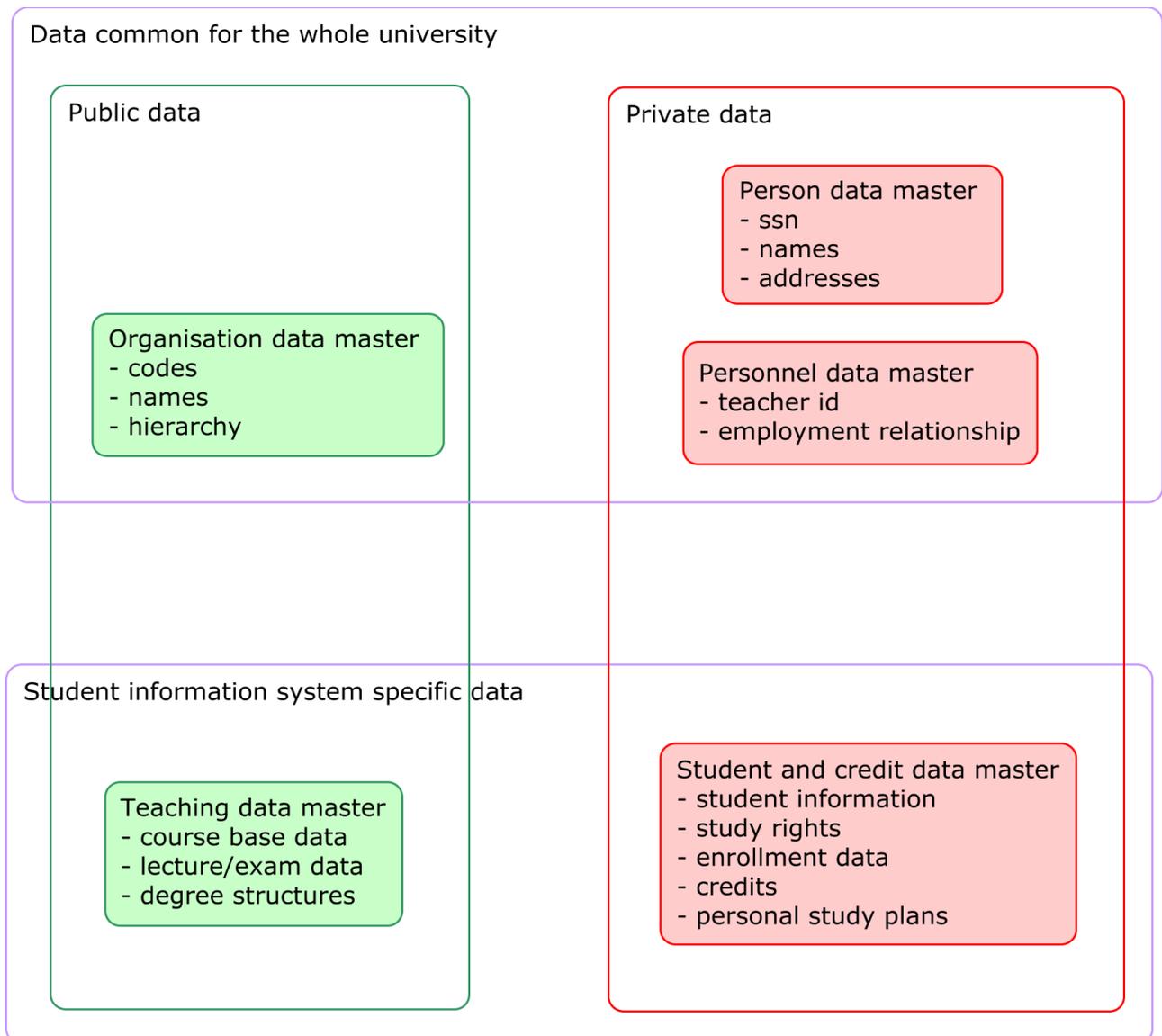
- Learning environments; compulsory items: implementation of teaching and enrolment
  - Semi-public level: communication open only to the group; learning material may be public



## Example of database consolidation and distribution



## Open data: example of the publicity of information



## Appendix 4. Suitability of solutions in view of the universities' enterprise architecture principles

This section compares the solutions presented for the modernisation of student information systems to the enterprise architecture principles at the University of Helsinki and Aalto University. The University of Tampere is currently drawing up principles for its enterprise architecture.

### University of Helsinki

Principle	A	B	C	D	E	Present state (Oodi)
<i>General principles</i>						
<b>Information system development adheres to the enterprise architecture approach.</b>	x	(x)	(x)	x	x	
<b>Information system development is open.</b>	x	(x)	(x)	x	(x)	
<i>Principles of functional architecture</i>						
<b>Enterprise architecture serves the University of Helsinki's core duties: research, teaching and community relations</b>	x	x	x	x	x	x
<b>Enterprise architecture supports the University's strategic plan.</b>	x	x	x	x		
<b>Functions common to units comply with consistent principles throughout the University.</b>	x	x	x	x	x	
<i>Principles of information architecture</i>						
<b>The concepts used in information systems are consistent.</b>	x		(x)	x	(x)	
<b>Information is in joint use.</b>	x	x	x	x	(x)	(x)
<b>Information security and privacy are taken into account throughout the life cycle of information.</b>	x	x	x	x	x	(x)
<b>Information has an owner.</b>	x	x	x	x	x	(x)
<i>Principles of system architecture</i>						
<b>Systems are in joint use.</b>	x	x	x	(x)	x	
<b>Systems are interoperable.</b>	x	(x)	(x)		x	
<b>Systems are user-friendly.</b>	x	(x)	x		x	
<b>System architecture is independent of technology.</b>	x		(x)	(x)	x	
<i>Principles of technology architecture</i>						
<b>Technology architecture is consistent.</b>	x	(x)		x	x	(x)
<b>The life cycle approach is taken into account in IT choices.</b>	x	(x)	x		x	
<b>The demands of sustainable development are taken into account in IT choices.</b>	x	x	x	x	x	x

## 1 Aalto University

Principle	A	B	C	D	E	Present state (Oodi)
G1: IT architecture principles are enforced	x	x	x	x	x	
G2: All IT architecture output is published	x	x	x	x	x	
G3: Open standards are used whenever possible	x	(x)	(x)		(x)	
G4: IT solutions must be modular in design	x	(x)	x			
G5: Buy before in-house development		x	x		(x)	x
G6: Acquire non-core IT functions when possible	x			x	(x)	x
G7: Ensure continuance of IT solution	x	(x)	(x)	(x)	x	
D1: IT project development is customer driven	x	x	x		x	(x)
D2: The project management office controls IT projects	(x)	(x)	x		x	
I1: Information and processes take precedence in the development of IT services	x	x	x		x	
I2: Information security is considered at the beginning of an IT project	x	x	x		x	
I3: IT service design must conform to the overall information architecture	(x)	(x)	x		x	
A1: System interoperability must be ensured	x	(x)	(x)		x	
A2: System interoperability is independent of location	x	x	x	x	x	
A3: Web browsers are the standard IT end-user interface	x	(x)	(x)		x	
T1: Technological complexity is transparent to the IT end-user	x	x	x		x	x
T2: The solution technology is modular and reusable	x		(x)		x	
S1: Aalto IT services are provided independently of location	x	x	x	x	x	
S2: The use of Aalto IT services requires no special IT knowledge	x	x	x	x	x	x
S3: Aalto IT service users are informed about Aalto IT services and associated conditions	x	x	x	x	x	x
S4: Service usage is completely separate from service management and service provision	x	x	x	x	x	x

(X) = Partly or potentially implemented, depending on the choices made within the selected solution