Project U-GOV

The new CINECA integrated information system for Higher Education

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1. EXECUTIVE SUMMARY

CINECA is an Italian consortium consisting of 32 universities. In 2005 CINECA launched the U-GOV project that aims at developing a new integrated information system for universities in which personnel, accounting and student systems coexist, together with decision support tools, in a unique and integrated environment. This new system channels in a single integrated suite the present CINECA applications designed for Higher Education (HE).

1.1. Background

In the new competitive context, universities are called to act with increasing efficiency in defining and realizing strategies, in planning and controlling resources, and lastly in complying with the aims and orientations set by governing authorities. Yet, they also must safeguard effectively the institutional aims and social role belonging to the traditional university system.

In such evolutionary process, the U-GOV project was developed to address the following emerging needs: enabling university governance, extending organization management, simplifying services development, improving core university processes, reducing complexity of technological and applicative infrastructures.

1.2. Alternatives

Two different kinds of IT systems have been spreading in the world of HE: best of breed solutions vs. ERP suites. Yet, neither solution has completely satisfied university needs. Best of breed solutions have high functional coverage, but weak data and process integration. On the other hand, ERP suites give strong integration, but weak flexibility and low functional coverage of university core processes.

1.3. Conclusions

CINECA designed U-GOV taking on an alternative approach based on these fundamental principles: system-wide shared information structure, process management structure, service oriented architecture (SOA), web services and open standards.

U-GOV consolidates and increases coverage of Financial, Student and Human Resource management, and extends the field of action by proposing solutions in new strategic areas, such as university Research. The Student module offers a system for the complete management of student careers (from recruitment to graduation). While the Research Management one enables the management of research products and the research assessment processes, helping researchers carrying on projects according to contract requirements, thus dealing with funding management and reporting, both

scientific and financial. The next challenge for CINECA and KION will be to define solutions to respond to Bologna Process-driven internationalization.

2. CINECA AT A GLANCE

CINECA was founded in 1969 as an Interuniversity Consortium to provide computing services for scientific research. Over time it has expanded its range of activities to support Higher Education institutions and the Italian Ministry of University and Research (MUR) in all key sectors of Information and Communication Technology. CINECA has become the largest high performance computing center in Italy and among the most important worldwide. Today this non-profit organization works as a high technology threefold partnership between the academic and research world, industry and public administration.

CINECA's aims are the following:

- To support the research activities of the scientific community through supercomputing and applications
- To develop information systems and services for Higher Education institutions
- To act as the information technologies outsourcer of the Italian Ministry of University and Research
- To enable the public administration and business companies to achieve real benefits with activity of technology transfer and custom designed products and services.

2.1. CINECA and Higher Education

HE institutions have unique organizational models and core processes compared to other business realities. Therefore CINECA is focused on developing information systems to support the specific HE needs, instead of re-engineering ERP systems developed for other markets. It provides a wide service offer as well, including hosting, networks, communication systems, portals and many others.

CINECA, as a consortium of universities, can leverage the domain expertise guaranteed by its members to better understand the needs of the market and serve it accordingly.

Since the 1980's CINECA has supported Italian universities in the transition to administrative decentralization. The system for managing university personnel (CSA) was the first step towards a technological solution which now covers the entire process of university administration.

Since the 1990's CINECA has started developing a system for accounting management (CIA) helping universities to introduce new management methods and practices. CINECA has also started supporting the Italian Ministry of Universities and Research by managing its technological links with universities.

The student management system (ESSE3) was born in 2000 and is developed by Kion, a CINECA owned company. In the same years CINECA designed the University Datawarehouse, a business intelligence system aimed at costs activities and performance control.

Throughout the years, CINECA solutions have widespread and have continued evolving thanks to the experiences and contributions given by customer universities.

Its long experience in academia allows CINECA to offer effective solutions, oriented to the governance as well as to the day-to-day management, thus promoting the mutual transfer of knowledge to improve service quality.

All these activities prove CINECA's significant commitment to Higher Education. CINECA is investing roughly 20% of its overall revenues in the HE systems research and development.

3. CONTEXT: UNIVERSITIES AND CHANGES IN PROGRESS

Universities are operating in a new context that is becoming more and more complex and competitive each year due to socio-economic changes, such as reduced public funding and national demographic loss.

The main trends and new challenges in HE can be summarized in the following points:

a. Definition of HE governance models. Universities are defining their own reference paradigms compromising the typical objectives of a public organization and the goals of private company.

b. Resources Management focus. Planning and Budgeting applications to control costs and to develop strategies are going to offer a competitive advantage to HE institutions.

c. Wide range of services offered by the university. Universities are continually required to face the development of new services and applications, combining data and functionality, especially in the core areas of education and research.

d. Reduced complexity in Technology and Architecture. Universities need to reduce the fragmentation of information systems and simplify information flow, process management, and integration interfaces between different applications.

e. Bologna Process-driven internationalization. In order to move toward a true European Higher Education community, systems need to be able to inter-operate and support mobility of resources and integration of data. HE institutions are going to push mobility of student, teachers, and researchers, as well as, foster International project collaborations as a competitive advantage.

f. Quality Assurance. HE institutions will put continuing emphasis and effort towards the assessment of quality in the core processes of learning and research.

g. Stronger local and national connections. Universities will aim to establish stronger relationships with local and national businesses and institutions.

This rationalization process requires both a systemic vision of the principal strategic areas and an ability to enhance the single special features of the university. It must safeguard effectively the institutional aims and social role belonging to the university system.

4. BEST OF BREED VS. ERP SOLUTIONS

Up until today the investments and the choices of the universities related to the adoption of information systems have been mostly driven out of necessity to fulfill the needs that required an immediate solution. Generally, the choices have been two kinds of solutions: Best of breed or ERP-type (Enterprise Resource Planning)

The Best of breed solutions identify those systems which best meet specific functional requirements, but they are not based on homogeneous architectural standard. They increase the proliferation of heterogeneous systems, complicating the integration among the various application modules. The obtained result is an information system based on heterogeneous functional modules, where each application has its data and functions separated from the other applications.

On the other hand, ERP-type systems respond to the integration challenge by employing modules that, coming from a single supplier, share a proprietary architecture. They partially overcome the integration problems of Best of breed approach, but the existing solutions available on the market are not covering all the requirements of a university. In fact, there are not specific vertical solutions for universities processes. Furthermore the ERP solutions don't always allow integration with other systems and are characterized by a scarce ability of adaptation with the evolving needs of a university; these factors significantly reduce the governance autonomy and development of the institution.

The combination of Best of breed solutions (typically used in the education and research area) and ERP solutions (often adopted for accounting and human resources) cause an objective integration problem with an increase cost of management. The applications don't "talk" to each other, they don't share data and they don't allow to reuse services nor cross-application components.

In recent years, the level of complexity of the management system of a university has registered a remarkable increase. The information system must always respond in short time to new requirements, simplifying the administrative or governance processes, through monitoring and evaluation tools.

The solutions, ERP and Best of breed, today still clash with the university needs of having flexible information systems that permit to optimize and integrate both the internal and external processes, beyond the border of its structure.

In the coming years the biggest challenge of the universities will be the attempt to manage the complexity with a systematic vision realized through an information system that could be shaped by and up to date with the evolution of technology.

5. THE U-GOV PROJECT

The U-GOV Project arises out of the need to answer to these changes in progress, both from a strategic and technological point of view.

With this project, in 2005 CINECA has kicked-off a new integrated information system for universities, U-GOV, which channels into a single systemic vision the current CINECA software solutions offered thus far (CIA, CSA, ESSE3).

The selection of the enabling technological platform immediately oriented the engineering of the new systems toward a Service-oriented architecture. This paradigm allows to overcome the limitations of the ERP and Best-of-Breed solutions, while combining their advantages.

U-GOV is designed to answers the challenges previously described in paragraph 3 as follows:

a. Definition of HE governance models: CINECA is developing hybrid models which merge the governance models of both public institutions and private companies.

b. Resources Management focus: U-GOV offers governance bodies the necessary instruments to constantly monitor performance and to plan and evaluate the strategies adopted. So, the university can intervene directly on the organizational model, putting into practice the corrective actions necessary to improve the services provided, controlling costs and optimizing the use of human resources.

c. Enlarging the range of services offered by the university. CINECA has adopted architectural specifications for U-GOV in order to sustain this change process without incurring further heavy integration costs. U-GOV has a single shared information structure and a SOA architecture. The technology of the system is based on open standard and ensures robustness, accessibility, reliability and high levels of applicative inter-operability.

d. Reduced complexity in Technology and Architecture. U-GOV reduces the complexity of information systems, simplifies technological and applicative infrastructures and handling of administrative processes. Moreover it allows the development of a flexible and customizable system able to adapt to the different organizational realities.

e. Bologna Process-driven internationalization. CINECA's systems are based on open standards and aim to facilitate systems inter-operability. CINECA is also actively participating in the definition of standards for the Exchange of student and curriculum data (Metadata for Learning Objectives, Rome Student Systems and Standards Group).

f. Quality Assurance. CINECA is addressing this issue through the development of Quality evaluation systems for products and projects related to the core HE activities.

g. Stronger local and national connections. CINECA aims at providing better tools for the dissemination of research products and resources through the development of portals and marketing platforms. U-GOV allows control of the processes going beyond the borders of the university itself and communicates with information systems and data banks of external entities, such as public administrations, the National Government, other institutions and universities.

In order to deal with such an ambitious project, collaboration was promoted from the beginning with some universities which provided an important contribution of the skills and professional competences they had available.

6. THE U-GOV SYSTEM: FUNCTIONAL COVERAGE

U-GOV offers complete management of the main functional areas of the university. It consolidates and enlarges coverage of the areas already supported by CINECA applications, such as Accounting, Students & Learning and Human Resources and extends the field of action by proposing solutions in new strategic areas, for example research.

The system is structured in *modules*, grouped in *functional areas* on the basis of the university administrative area to which they refer. These are:

- Planning and Controlling
- Accounting
- Human Resources
- Students and Learning
- Research

The articulation of the U-GOV modules in the different functional areas is shown in the solution map below, which presents the functional coverage of the system.
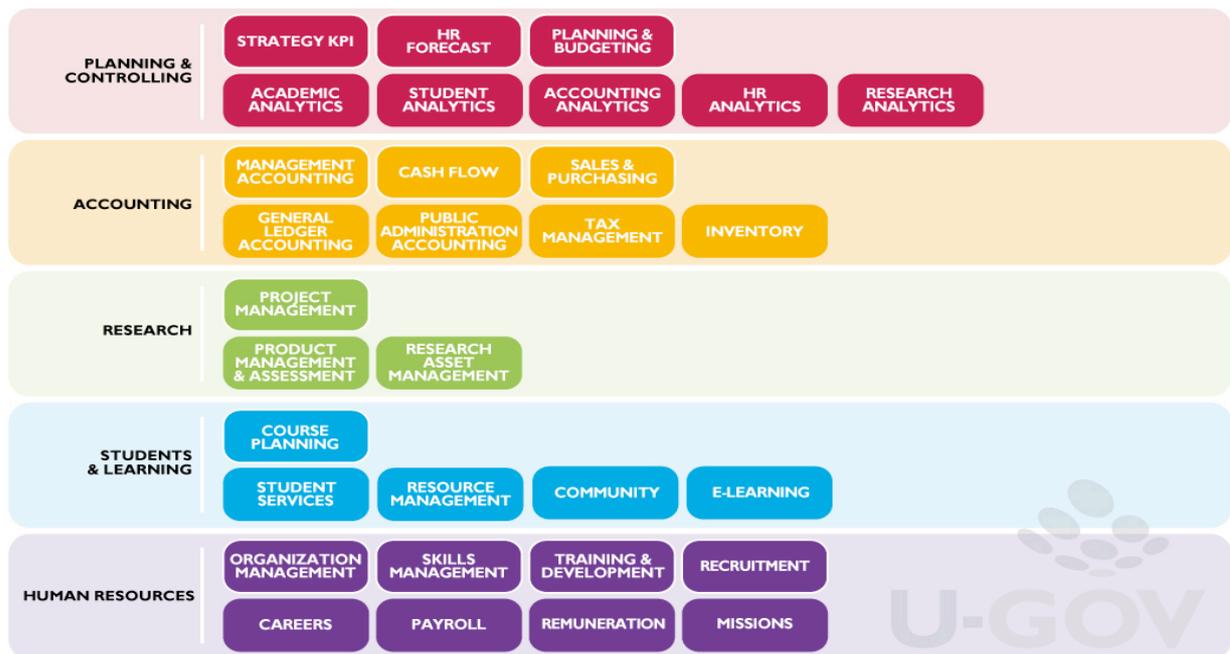
Figure 1. U-GOV Solution Map

7. THE U-GOV SYSTEM: ARCHITECTURAL PRINCIPLES

U-GOV is based on certain fundamental architectural principles, which may be summarized in the following points:

- Shared information structure
- Process management structure
- Service oriented architecture (SOA) and web services
- Open standards.

7.1. Shared information structure

The use of shared data registers throughout the applicative layer permits data sharing through the different processes, avoiding information duplication. Modifications to data are made visible in real time in all applications. The integrated information base is the fundamental premise for the development of university governance and to ensure and facilitate integration and evolution of the services offered by the University.

7.2. Process management structure

U-GOV is characterized by a software layer common to all modules, specifically dedicated to the management of internal university processes, which defines a model of interaction and integration between the applicative components. This allows the definition of information flows and reduces the fragmentation of processes. Thanks to the separation between process rules and registration functions, U-GOV may be easily adapted to changes in management rules without direct modifications of the code. This feature allows to change the process configuration to put into practice decisions concerning university governance.

7.3. Service oriented architecture (SOA) and web services

The SOA architecture consists concretely in a layer of services which enables access to data and functions of the information system in a manner which is transparent and reusable for other applications. This feature allows management of the complexity of the system itself, thanks to a set of components, which the application makes available following the standards, formal or de facto, on the basis of the SOA architectures. Another strong feature of U-GOV is its use of web services. By means of web services the applicative components of U-GOV make their functions available through interfaces accessible to other applications. This improves the applicative cooperation capacity, facilitating data access and strengthening operative flows and synergies between different information systems.

7.4. Open standards

The use of open standards, in particular the JEE standard for the development of applicative components, permits development of communication between different modules and the provision of distributed, secure and inter-operable applications.

8. U-GOV ARCHITECTURE: LOGICAL VIEW
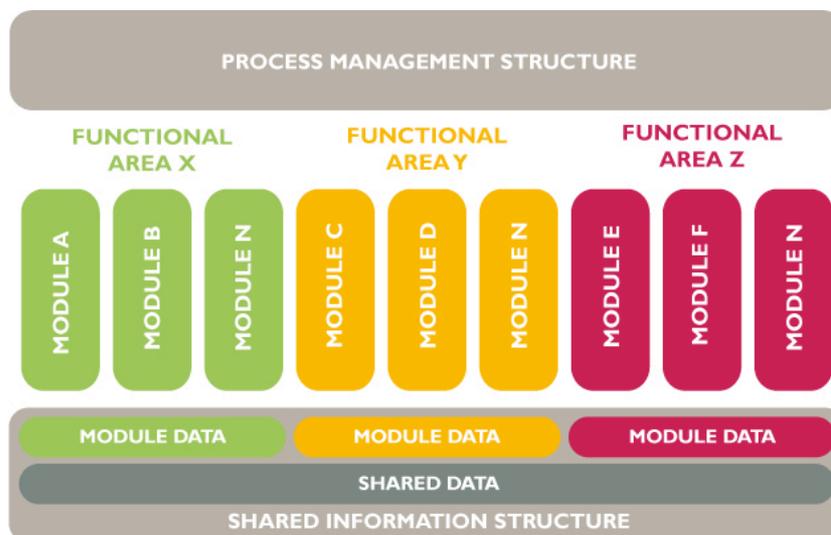
Figure 2. U-GOV architecture: logical view

In a logical-functional perspective, U-GOV is composed of three interconnected layers: the shared information structure, the layer of applicative components and the process management structure, as shown in the diagram above.

Data management takes place at two levels inside the U-GOV architecture. The first consists of common data, describing general information concerning the whole system. The second consists of modular data registers, deriving from elaborations made by the applicative components.

The applicative layer consists of U-GOV modules. Module is to be intended as the elementary and independent component of the offer. The U-GOV functional Areas (for example U-GOV Research) consist of logical groupings of several modules performing activities inside the same administrative area.

The U-GOV process is the applicative representation of a university process which the University activates internally and wants to manage and monitor. It therefore describes a process in terms of rules, documents, phases, constraints and decisions mapped out within the system. The U-GOV processes permit the different functionalities present in the modules to be linked and orchestrated, even if they belong to different functional Areas, producing more complex processes.

9. SYSTEM ARCHITECTURE: TECHNOLOGICAL VIEW

From a technological point of view, U-GOV is composed of three main layers, represented horizontally in the figure below: DBMS, Application Server and Web Server. For each of these layers the infrastructural components are highlighted: the database instance, the business components, the presentation layer and the C-Frame framework divided into back end (inside the application server layer) and front end (included in the web server layer) frameworks.

Each of the elementary components of the U-GOV architecture is based on the most widely used Java Enterprise pattern. The corresponding open standards of reference for each technological level are listed in the right column.
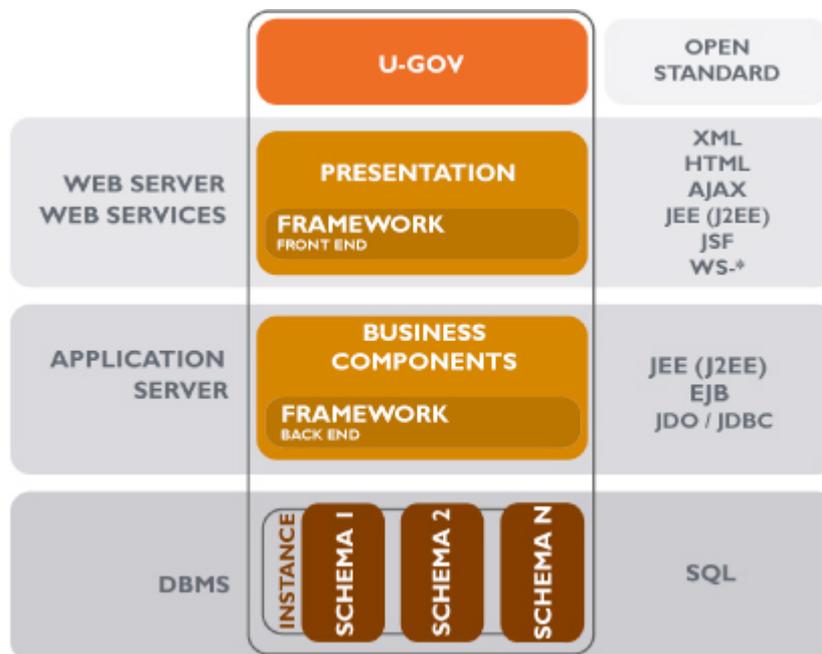
Figure 3. U-GOV architecture: technological view

The U-GOV database identifies the set of components which host "data"-type objects and offer access services to the data itself. It is articulated in different logical schemes inside the same instance, each of which coincides with the database of a U-GOV module, or with the repository of data common to the whole system.

The C-Frame framework supports integration of the applications inside the U-GOV system allowing use of the infrastructural services offered by the architecture. It also rationalizes a set of common functionalities containing the best practices and patterns to be applied during development of the purely applicative components. The C-Frame is divided into two layers:

- The back end Framework provides the set of components and services utilized by the system to perform basic operations of data, both common and modular. Specifically, the persistence engine contains the data management and memorization components which are performed on the database
- The front end Framework provides the interaction functionalities transversal and common to all presentation components as well as the mechanisms of system access authorization and control.

Business components are to be understood as the components of U-GOV meant to handle the applicative logic of the system. The various components, grouped together logically, make up the U-GOV modules, which in their turn define the functional Areas of the system.

The U-GOV presentation layer contains the components which handle management of the interaction between users and the applicative pages of the system. As with the business components of the application server, the presentation components are also organized according to the modules and Functional Areas of U-GOV.

The U-GOV system is able to display its applicative functionalities through the use of web services. They therefore represent the public elements of integration with other information systems, such as university portals or other applications that have to inter-operate with U-GOV by exchanging data or orchestrating services.

10. U-GOV FUNCTIONAL AREAS: BENEFITS AND FEATURES

10.1. U-GOV Planning and Controlling

U-GOV offers maximum integration and sharing of information between the accounting department and planning instruments, both at the forecast and final balance stages. It is thus able to make an immediate analysis of variances as well as to monitor a set of extra-accounting indicators which enrich the results of the exercise with qualitative information.

Planning is developed in U-GOV both strategically and operationally. Strategic planning is conceived as support tool for the governance actors in defining the objectives. Operational planning is made with great flexibility in order to permit an authorized expense process or a more complex mechanism of financial negotiation. The operational planning automatically generates part of the estimated balance statement and, if required, the financial budget.

10.2. U-GOV Accounting

Administrative and financial processes are completely supported right through to operational details and are represented swiftly and coherently in internal and external statements and in Management Control.

Thanks to the *Process management structure* U-GOV allows the university to shape different processes without forcing it to adopt a standard model. In the same way, every independent structure inside the university can design its own processes. CINECA provides a range of best practices and success models customized on dimensions and activities.

In the Italian HE system, CINECA is helping universities to integrate Public Administration Accounting and General Ledger Accounting as complementary methods. In U-GOV these two methods coexist as different and integrated views of the same reality, eliminating duplications of information and activities.

10.3. U-GOV Human Resources

U-GOV supports Human Resources management in increasingly broader contexts, financial management, development planning, skills analysis, assessment and training.

A strategic aspect is the sharing of data of persons and organizational units at system level. For this reason U-GOV is able to give a single identity to subjects and structures participating in different processes across different areas.

10.4. U-GOV Students and Learning

U-GOV guarantees comprehensive management of the student's entire life-cycle:

- Recruitment and enrolment
- Student's career management, both from the administrative point of view (mobility inside and outside the university, student billing and financial management) and from the teaching/learning point of view (management of teaching and courses, teaching delivery and assessment, registration, grades, transcripts)
- Student placement, and internships management.

The U-GOV course structure planning is inherently conceived to integrate information and to handle all processes, whether internal or external of the university, directed towards the Italian Ministry of Universities and Research and other organizations.

U-GOV Students and Learning is integrated with some of the most important e-learning platform (course management systems, Moodle, etc.) in order to simplify the delivery of teaching online and on-demand.

CINECA and its company KION are now defining solutions to face the internationalization of the Bologna Process.

10.5. U-GOV Research

U-GOV provides consistent management of all Research projects activated within the university, both from the operative and from the financial point of view. It also creates a single database of research products that have been developed by university researchers. Hence it offers a basis for rationalizing use of resources, optimizing project management, monitoring and assessing projects as well as products, checking achievement of objectives.

The Industrial Liaison Office can easily publish online portals and catalogues of research, labs and instruments, researchers and groups, skills and know-how. This leverages the relationship and the transfer of know-how and technologies to the territory and to business companies.

U-GOV supports researchers in managing the call for the submission of funding requests, it also works in progress evaluation, financial and scientific reporting. In interuniversity consortia U-GOV simplifies the process integration and data exchange.

11. STATE OF DEVELOPMENT AND FUTURE PERSPECTIVE

The original CINECA applications for HE are widely spread across Italian universities today. For this reason CINECA has designed U-GOV in order to ensure maximum compatibility with the preceding generation of applications. In this way the university can set up a gradual and feasible migration plan to deal with organizational evolution and the safeguarding of existing data and services.

Since 2006, the first U-GOV applicative modules have been completed and tested by some Italian universities that collaborated in the analysis stages. They are now being used daily by an increasing number of customers. Today, the most widely adopted U-GOV modules are U-GOV *Product Management and Assessment* and U-GOV *Course Planning*: by the end of 2008 they will be implemented in about 15 Italian universities. A lot of other universities have also implemented U-GOV Planning and Controlling modules, starting from the analytics.

The next two years will be critical for the project success. In 2009 main U-GOV HR, Accounting and Students management modules will be released and customers that are now using previous CINECA application in those areas will be migrated to the new system according to the roadmap.

In order to enlarge its offering, CINECA is looking for partnership with companies which develop applications that can be integrated in its product suite. These third party applications must enhance areas that are not yet covered by CINECA applications.

CINECA is also planning to design services to support communication and marketing based on a multichannel/multimedia approach. Communication and marketing in the university aim at adding value to the services offered by the institution to recruit local and foreign students. At the same time, the university needs to promote its own scientific research production and the internal know-how to engage collaborative relationship with industry and other institutions. The objective is to increase loyalty of its own stakeholders' community (students, teachers, researches, alumni, companies, public institutions…) and to harmonize the different channels through which relationships are fostered.

The university portal is the first step to collect information from all the internal structures (departments, labs, courses, research bodies) and to define the digital identity of the university. In order to carry out the communication and marketing strategy CINECA wants to customize information systems to help the university manage the content production cycle, the delivery of information, the target profiling, as well as the maintenance, update and monitoring of the marketing campaigns investments and results.