Quality and accreditation in a French digital repository

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Summary

In the digital data preservation context, the current challenge lies in the evaluation of the quality of the service provided. The CINES (Centre Informatique National de l'Enseignement Supérieur) deployed PAC (Plateforme d'Archivage du CINES) in 2006, one of the very few operational long-term preservation platforms in France, in order to preserve data produced by research laboratories and organizations. To lock the mandate given by the national education ministry, but also to improve confidence in the service and prove its powerful effectiveness, the CINES strategy relies on the "quality assurance" approach, both technical and organizational, based on accreditation. During the last four years, the PAC staff has run five internal and external audits, involving different standards. These audits highlighted the strengths and weaknesses of the service and action plans have been put together and executed to improve the quality of the delivered services. With such an experience, CINES now shares its expertise with the digital preservation community.

Introduction

Information in a digital form is now omnipresent in our society, with huge volumes and multiple formats. Despite its complexity and volatility, it's a genuine testimony of activities, an archive, for which preservation is a concern. Thus, the stakes of digital preservation are high, as they reside in the deployment of the means required to guarantee the heritage conservation, from the short term to the long term. The risks associated to digital information have now been identified for quite a while, and can be summarized in four main threats: the deterioration and ageing of storage media, the disappearance of read hardware or software, the impossibility of reading the format of the files containing the data, and the lost knowledge of the content of digital objects. Preserving digital data consists of preserving the document (while guaranteeing its integrity and authenticity), while keeping it accessible and understandable. The complexity of such a task is tightly bound to the preservation timescale. Within a few years period, the problem is relatively easy to deal with. Good quality and secure IT storage guarantees against accidental loss of the document. Technologies won't have changed so much that the document will have become irremediably unreadable. Finally, the community of potential users of the document will most likely be scientifically and culturally similar to the one which created the document a couple of years earlier, so the need for an exhaustive information description is not so strong. Within a wider period however, none of this is a foregone conclusion, unless someone has thought of accompanying the document over time, and requirements for comprehensiveness and legibility become mandatory.

For these reasons, the French ministry for Higher Education and Research gave the Centre Informatique National de l'Enseignement Supérieur (CINES) the mandate to implement and experiment a project in long-term preservation of records and data. CINES is a state administration institution based in Montpellier (France) which employs about 50 engineers and which is known worldwide for its HPC (high performance computing) activities. The whole CINES infrastructure and means is made available for all

the French researchers, who are split up into scientific domains. The largest communities to use the CINES computing services are the fluid mechanics, chemistry and climatology research communities. As part of this initial mission, CINES hosts advanced computers which include Jade (SGI ICE 8200 EX with 267 TFlops peak, 23 040 cores and 700TB of disks).

The CINES mission for digital preservation eventually resulted in the deployment of one of the very few operational long-term preservation platforms in France for the Higher Education and Research community. In 2006, just two years after the first activities on digital preservation had begun, a first repository, which had been developed internally, was rolled out with the objective to preserve the electronic PhD theses. This infrastructure is called PAC (Plateforme d'Archivage du CINES – the CINES digital preservation system). Since March 2008, the documents have been preserved on PAC-V2, which relies on the Arcsys software published by Infotel as well as on specific additional modules (ingest, data integrity control, statistics tool modules, representation information library…) developed in-house. At the moment, the preservation team is made of eleven people with different profiles, skills and experiences: I/T manager, archivist, file formats experts, I/T developers, system administrators, XML specialist, hardware and OS specialists, service support and monitoring specialists. The scope of data to be preserved is pretty wide, as it covers the digital heritage of the whole Higher Education and Research community. This includes educational data (courses, digitized books, theses, etc.) as well as research data (papers, simulation or computational results, etc.), or even administrative data from universities (personal/students records, financial records, etc.). Currently, PAC stores about 22 TB of data in the production environment:

- ✓ Digital PhD theses;

- ✓ Scientific papers uploaded in the open repository HAL (Hyper Article on Line) managed by CCSD;

- ✓ Digitized publications as part of the Humanities and Social Sciences program « Persée »;

- ✓ SLDR Multimedia collection (sound files of ethnographic recordings in various languages) as a pilot project of the Humanity and Social Sciences program « TGE-Adonis »;

- ✓ Digitized collection of the history of law of CUJAS university library;

- ✓ Digitized collection of books about the History of Medicine (BIU Santé - Inter-university library of healthcare);

- ✓ Digitized works in medicine, biology, geology and physics, chemistry (BUPMC - University Library "Pierre and Marie Curie");

- ✓ Digitized collection of books of the Sainte Geneviève library ;

- ✓ Library of photos of the French School of Asian Studies (EFEO).

CINES has other preservation projects: data produced by INSERM[1] as part of medical research, administrative records extracted from CNRS[2] applications, as well as a couple of projects as part of the Humanity and Social Sciences program « TGE-Adonis » such as archeological data or language research data.

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[1] National Institute of Health and Medical Research.
[2] National Centre for Scientific Research.

Quality assurance at CINES

Preserving the data over time requires the implementation of a rigorous quality assurance approach, in order to manage and mitigate the risks associated to this activity. This is even more necessary that the demonstration of the level of quality of a service is a prerequisite for any certification initiative. For these reasons, the CINES strategy encompassed the improvement of the quality of the service provided based on various standards like ISO 14 721 (Open Archival Information System), AFNOR NF Z42-013 (French recommendations about conception and utilization of systems with data to preserve), PAIMAS (Producer-Archive Interface Methodology Abstract Standard), SEDA – a French standard about archives exchanges (Standard d'Echange de Données pour l'Archivage[3]), P2A - Politique et pratiques d'archivage (policy and pratices about preservation in a French public environment[4]), etc.

Besides the strict adherence to these standards, the quality approach *via* best practices in this field can be seen from two aspects, technical and organizational.

Technical quality

The technical quality approach to preserving digital documents covers all the procedures aiming at ensuring a high level of quality of the digital object itself. At CINES, the technical quality can be seen on the fields of metadata, file formats and storage levels chosen.

Metadata are data which are used to preserve information describing digital objects; in this case, we mean preservation information (description of the information content, its origin or source, and its history) and content information (technical aspect of the information, its structure or format, and access rights). To reflect the heterogeneity of preservation projects, while ensuring understanding of archived documents through time, CINES has chosen to combine several sets of metadata at different levels:

- ✓ Metadata describing the archival project based on ISAD(G) and ISAAR(CPF) to document some information, like the context of the funds to preserve as a whole, producers, data submission services, and the choices made for the preservation project.

- ✓ Generic metadata for each information package based on the unqualified Dublin Core metadata set, enhanced with a set of management metadata developed specifically, following ISAD(G).

- ✓ Any specialized metadata set used by the producers to describe their documents (like ISO 19115 for geographical data, OLAC in linguistics, etc.).

Besides interoperability, the use of standards makes controls that can be performed to check the level of quality a lot easier.

The same approach can also be applied to the quality of file formats archived. Indeed, files must strictly conform to their format specifications in order to be readable and convertible over time. So, to get into the CINES digital repository, every file has to be identified, validated and eligible for long-term preservation. On this last point, CINES gives priority to mastered file formats which means formats whose specifications are published (i.e. PNG, ISO 15948) and standardized if possible (i.e. PDF, ISO 32000-1), and

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[3] Ministère délégué au budget et à la réforme de l'Etat (direction Générale de la modernisation de l'Etat), Ministère de la culture et de la communication (direction des Archives de France), January 2010, *Standard d'échange de données pour l'archivage : transfert – communication – élimination – restitution*, Paris.

[4] Prime minister's office, July 2006, *P2A – politique et pratiques d'archivage (sphère publique) et grille d'audit,* Paris (France) : http://www.ssi.gouv.fr/fr/bonnes-pratiques/outils-methodologiques/archivage-electronique-securise.html.

above all widely used by the producers community. Currently, this represents a limited list of fifteen file formats (text, images, sound, videos, etc.). Free tools (like Jhove and DROID) and format-specific databases (PRONOM) which are authorities in the field of digital preservation, had been integrated by CINES in order to identify, validate and characterize files and ensure they are eligible for long-term preservation. Besides, CINES preserves file format specifications and XML schemas under the same conditions than documents in order to have complementary representation information. In order to raise awareness of potential users of PAC on this particular issue, an online tool has been developed in-house to control file formats quality: FACILE (in French, stands for the word "easy" - validation of archive format by analysis and expertise)[5]. It validates the format quality of files to be preserved with the same validation process (tools and list of formats) as the PAC platform. The application code is free and open to allow integration into business applications of other institutions or organizations concerned. Moreover, CINES offers to users a second level support to resolve more complex issues of non-compliance.

Beyond these specific aspects, the technical quality also concerns the proper conservation of bitstream data stored on physical media. The information storage strategy adopted at CINES is a mix of disk and tape copies: four copies are made of each document, including one in a remote site of several hundred kilometers. A regular audit of all copies will detect any corruption or damage, and apply corrective measures if required. This integrity control can be done by the hardware, by CRC algorithm by the disk or network controllers, or by the software itself, by comparing sampled checksums with the initial ones using hash algorithms (MD5, SHA-256, etc.). Several studies have been conducted in France into the reliability of storage media, their age resistance and silent corruption of the data[6]. The results are enlightening as well as an incentive to the greatest vigilance towards this area. So, technical quality is therefore mandatory, but is only relevant when the preservation process as a whole is organized with the same requirement for excellence.

Organizational quality

The fulfillment of a quality approach on the organization of the CINES digital preservation service has been a global project involving all the staff in terms of identifying business processes and risk management, with a perspective of an eventual certification. The first point of this approach consisted of identifying and document all the business processes implemented at CINES for the long-term preservation of digital documents. Such an initiative has multiple benefits:

✓ First of all, the formalization of business processes is the backbone of service documentation. From the perspective of very long-term preservation, information about all procedures applied to archived documents has an obvious meaning and interest, and forms the basis of service knowledge.

✓ Then this formalization allows an ongoing self-assessment of the organization, through regular review and appraisal, and therefore a continuous improvement of overall system performance and service provided.

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[5] http://facile.cines.fr/

[6] J.C Hourcade, F. Laloë, E.Spitz, « Longévité de l'information numérique, les données que nous voulons garder vont-elles s'effacer », EDP Sciences, 2010

[6] J.M. Lambert, J. Perdereau, « Qualité des CD-R disponibles sur le marché pour l'archivage des données numériques », Ministère de la Culture et de la Communication – Direction des Archives de France, 2008

✓ With a similar focus on assessment and improvement, it allows a more efficient comparison of operations of two structures that have a similar documentation of business processes.

✓ Least, business processes formalization is of great help for internal and external communication improvement: it is a way to reduce internal compartmentalization across services, and allows a greater transparency in working methods, which is essential to establish and maintain trusting relationships with partners, governing bodies and user communities.

This approach began with the choice of a set of rules of formalization and relationships between objects forming a metamodel. At CINES, the chosen metamodel is based on graphical representations for more readability and additional descriptions (or descriptive sheets) for greater compliance with ISO 9001 and 9004 standards. The analysis of major specific functions related to digital preservation at CINES was based on functional groups defined by OAIS (ISO 14721). That resulted in the identification of fourteen processes, divided up into a number of sub-processes and activities. Each process is assigned to a staff member, who is preferably in charge of its daily execution, and who is responsible for its formalization and update in accordance with the evolution of the service. Started in 2009, this design activity took nearly eighteen months. The outcome of this initiative was partially presented during international conferences[7], and can be accessed online on the CINES website[8].

At CINES, organizational quality also depends on a management approach of the risks bound to digital preservation. The aim here is not to eliminate the risks, but to determine acceptable levels of risk and mitigate them before damage occurs. In order to do this, CINES identified and classified risks that could impact the proper performance of its service, based on the DRAMBORA framework[9] and its online tool. The results of this audit led the CINES to define a tailored risk management plan: thirty eight main risks have been identified and defined from the seventy eight risks listed in DRAMBORA. Then, each risk has been assessed by the whole team by evaluating its probability and impact over time. A risk priority index (RPI) has been calculated on two dimensions (impact x probability). It allows identifying risks with the highest priority and the way they should be dealt with by associating necessary action plans to reduce the level of risk, by mitigating their probability or impact. In the particular case of the PAC service, the risk management plan was established in 2009 and is still reviewed every six months by the whole team.

In a nutshell, the CINES policy for improvement is totally part of the accreditation process, and even upstream, because it is crucial to ensure that the quality of service provided is consistent in respect of various criteria required for certification.

Accreditation approach at CINES

Certification is the ultimate goal of the consolidation of an organization and/or service. It recognizes its quality and professionalism, and therefore establishes trust with communities of users, and potentially leverages budgets from funding bodies. However, certification requires a lot of financial/human involvement. Thus, it is extremely important to identify beforehand the most relevant type of certification in light of the objectives and means that can be implemented to achieve them.

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[7] O. Rouchon, M.Massol, « Quality insurance through business process management in a French Archive», iPRES 2010, http://www.ifs.tuwien.ac.at/dp/ipres2010/papers/massol-6.pdf

[8] http://www.cines.fr/

[9] Digital Repository Audit Method Based on Risk Assessment, developed jointly by the Digital Curation Centre (DCC) and Digital Preservation Europe (DPE).

Goal and Strategy

As the engagement letter issued by the Ministry of Higher Education and Research initially limits the mandate to a four years span (2008-2012), CINES must prove itself and lock the mission in the long term given the importance of the financial, technical and human resources required to execute it. A dedicated department has been set up for this purpose which will only be relevant from an economic point of view if archived volumes increase significantly and CINES settles its legitimacy. Hence, the main objective of the approach is to get an official recognition that would allow to:

✓ Label the service;

✓ Legitimate its qualification;

✓ Become a professional in the French digital preservation community that cannot be ignored;

✓ Get a strong marketing point to develop the service with other communities;

✓ Communicate with the funding bodies.

Therefore, CINES tried to identify the most relevant certification from the perspective of governing bodies: neither too general to sufficiently integrate digital preservation specificities, nor too specific to be visible and meaningful to the authorities. In 2008, the first step consisted of producing a report on the state-of-the-art of existing certifications. CINES had highlighted the lack of specific, recognized business standards in the non-archivistic community. Year after year, a large growth of the certifications standards can be observed, among which:

✓ 2006-2007: the methodology for self-assessment the Digital Repository Audit Method Based on Risk Assessment (DRAMBORA);

✓ 2007: TRAC "Trustworthy Repositories Audit & Certification (TRAC) : criteria and checklist";

✓ 2009: Data Seal of Approval, developed by DANS;

✓ 2012: ISO 16 363 ("audit and certification of trustworthy digital repositories");

✓ In progress: ISO 16 919 ("requirements for bodies providing audit and certification of candidate trustworthy digital repositories");

✓ In progress: French standard for certification based on the NF Z42-013 standard (now ISO 14641-1).

Given the lack of really appropriated certification in 2008, and with a proactive approach, the strategy of CINES was to cover a large spectrum of standards and to increase the level of complexity required by the targeted certifications over time. Thus, the standards used for the first PAC accreditation were simple and based on self-assessment. The closer CINES gets to 2012 (the end of the span of the preservation mandate as per the mission letter issued by its Ministry), the more complex the certification standards are, to reflect the latest acquired experience and competencies. Generalist certifications, such as ISO 27 000 (IT security), ISO 9000 (quality), CMMI (engineering), or ITIL (services), though best known by the governing bodies, were not included in the CINES approach because they do not sufficiently take into account the specificities of digital preservation and are therefore not able to express according to us the quality of service offered.

Tested certifications

Over the past four years, the long term digital preservation service of the CINES ran not less than five audits, internal as much as external, based on various level of system of reference. In addition to the continuous improvement of quality through internal assessment, the first step towards accreditation has been materialized by conducting an external audit in 2009. Following the inconclusive results of the survey of existing certifications, it was decided to conduct an audit of pre-certification without imposing a particular system of reference or standard. The selected provider suggested building a customized audit grid based on:

- ✓ The coming ISO 16 363 standard;

- ✓ "Trustworthy Repositories Audit & Certification (TRAC) : criteria and checklist";

- ✓ The checklist of the NESTOR project (Network of Expertise in long-term STORage Working Group on Trusted Repositories Certification)[10];

- ✓ The preservation policy audit grid as developed by the French Agence Nationale de la Sécurité des Systèmes d'Information (ANSSI);

- ✓ The OAIS conceptual model - ISO 14 721;

- ✓ The French NF Z42-013 standard.

The resulting grid was filled by two external consultants from evidences found in the documentation or observations from interviews with the whole staff of the digital preservation service and the members of CINES management. It was included in the final report which was structured as per the ISO 16 363 recommendations. The workload associated to this audit represented nineteen man-days.

Figure 1. CINES strategy for certification

The next step in CINES accreditation process has been to consider a European accreditation: the DSA « Data Seal of Approval »[11]. This seal, which was initiated by the Netherlands in 2007, is granted to the digital preservation centers, for establishing quality assurance procedures to ensure accessibility and intelligibility of information entrusted to them. To get the accreditation, which is based on trust, CINES had to submit a request on the web which consists of a self-assessment of the sixteen Data Seal of Approval guidelines. As part of this process, it is requested to describe in a transparent and open manner how these guidelines relate to the repository and how they have been implemented in the current situation. After testing a first version of DSA in 2009, the CINES digital preservation repository (PAC) now
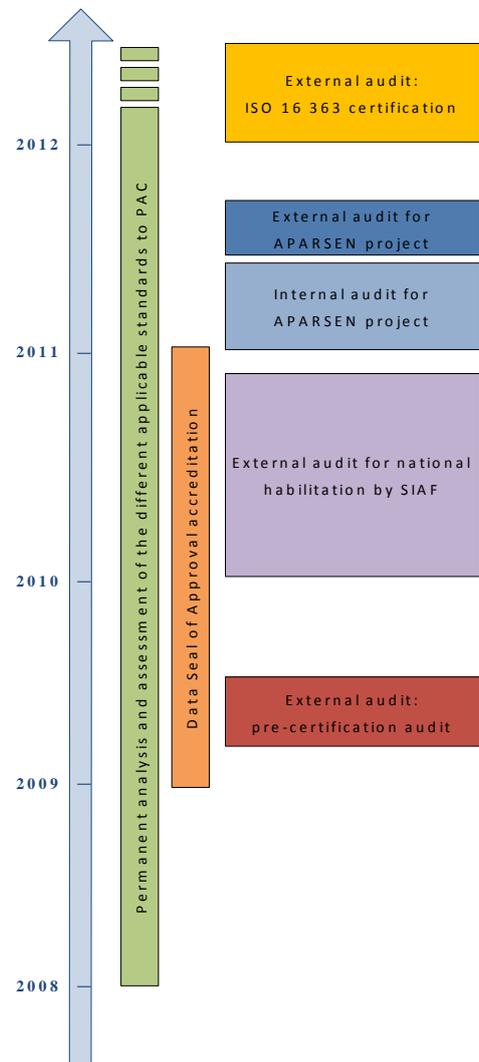
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[10] http://www.langzeitarchivierung.de
[11] http://www.datasealofapproval.org/

complies with the 2010 guidelines version 1 set by the Data Seal of Approval Board. The repository has therefore been granted the Data Seal of Approval for 2010 on March 15, 2011.

Meanwhile, a new version of the French law about archives, issued in 2008, now allows organizations to store and preserve on the national territory some public records (non-heritage) provided that they have received an authorization from SIAF (Service Interministériel des Archives de France). CINES, as a public institution, and given the need expressed by its community, decided to position itself on this sector. The requirements from SIAF consist of twenty-two technical, operational, organisational, strategic and legal criteria, based on the standards of the domain such as ISO 14 721 and NF Z42-013. In June 2010, CINES completed and sent a report to the Service interministériel des archives de France (SIAF) in order to officially request such a capacitation. After few months of investigation, a group of eleven experts visited the CINES facilities and interviewed its representatives before issuing the authorization on December 14th, 2010, for the next three years. SIAF also provided a list of conditions and recommendations for its renewal, some of which had not be identified during the previous audits. CINES has already taken them into account in a specific action plan.

The latest step in the CINES accreditation process catch up to their primary objective, that is to obtain the most relevant certification from the perspective of the funding bodies. It is divided into two phases, a first internal audit, followed by a second external, both realized in 2011 as part of the European initiative APARSEN[12]. One of the APARSEN objectives is the test audit of six digital repositories based on the ISO 16 363 standard (in progress at that time), half of them being based in Europe, and the rest in the United States. The European datacentre being audited as part of the APARSEN projet were: The UK Data Archive (UKDA), United Kingdom; The Data Archiving and Networked Services (DANS), Netherlands; and The Centre Informatique National de l'Enseignement Supérieur (CINES), France. The experts in charge of the internal audit at CINES (three people) were chosen because they had a good understanding and knowledge of the digital preservation process or the functional and technical management of preservation projects in PAC. Their recommendations in the final report have been made from assessment and observations, especially based on compliance in the 2009 external audit, improvement of compliance as part of the completed action and/or produced documents and gap between available documents and requested artefacts. The workload for this internal audit was evaluated around sixty man-days in order to perform a preliminary study (analysis of the reference document, definition of the scope of the audit, preparation of the main deliverable – report document in French, planning) and the internal audit (evaluation and documentation of the criteria fulfillment in French, translation of the report in English language, additional interviews and verifications, gap analysis with the 2009 external audit report), to prepare the documentation requested by the external APARSEN auditors and to validate the internal audit report/summary.

The external audit was executed by twelve independant international experts nominated by the APARSEN consortium. The audit started with an overview of the CINES approach and implementation to provide long term preservation of digital objects, followed by a visit of the facilities and a demonstration of the repository capabilities. Then, the auditors reviewed the report produced as part of the internal self-audit, and a question/answer session helped clarifying the remaining ambiguities. As a conclusion, the auditors expressed remarks and recommendations for CINES to improve the quality of the services provided, where necessary. The other objective of the APARSEN audit was to gather feedback from the institutions being audited as to the relevance and usability of the criteria listed in the standard. In some ways, it

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[12] http://www.alliancepermanentaccess.org/index.php/current-projects/aparsen/

helped clarifying the ISO 16 363 criteria evaluation system (methods/model for criteria appraisal, characterization of mandatory/optional compliances, etc.), as some questions were raised during the self-audit on this particular topic, and were clarified in the final version of the standard published in February 2012.

Feedback on this experience

The accreditation initiative that was kicked-off four years ago has been of great help for the improvement of the quality of the services provided. Strengths and weaknesses have been highlighted and action plans have been associated to them. Priority actions were generally more related to policy, strategy, finance and preservation plans rather than on organizational aspects. As a result, in 2009 and 2010, the CINES management focused on the improvement of these criteria. The outcome of the internal audit executed in 2011 confirms the efficiency of the action plans implemented and the progress made over this period.

In the meantime, these audits allowed finding out some critical aspects which had never been met by the repository, among which:

- ✓ The gap in the level of knowledge within the team, and in the distribution of critical activities inside the staff;

- ✓ The lack of end-to-end traceability for the object integrity during the ingest phase, that led to the obligation for the data producer to provide an initial checksum;

- ✓ The lack of formalization of some specific topics or processes (disaster recovery plan, business continuity plan, etc.).

As part of the deliverables, the auditors also provided additional reports that allowed to back the demand of a long-term mandate and financing for the CINES. Even if the external auditors are not necessarily aware of the specific culture of the audited repository and staff, their fresh eyes on the project proved to be extremely valuable to argue the evidences, support some projects to improve quality (development of new internal modules for the repository, validation of contracts by a lawyer, etc.) and even suggest interesting things to look at and think about (potential strategic developments, internal communication improvement, etc.). From this point of view, the fact that the external auditors belonged to the digital preservation community and had a strong expertise of the domain was key to the success of the initiative. However, it is important to consider that the success of such a project requires the commitment of each individual involved in the preservation process. Thus, the quality strategy at CINES is a part of the global organization strategy decided by the organization management, which has implemented an important communication policy to prevent any rejection by the team: the strategy for the evolution of the legal context (mission) was explained, regular meetings detailed the choices made, as well as planning, relationships between team members and audit process, progress and results of audits, consequences of audits on daily work, etc. The will for transparency that prevailed in this project has contributed to its success: the final objective was the realistic evaluation of the services provided to the communities, not a mean for the reorganization of the department. So, the human investment was decisive to identify nonconformities and execute efficient and relevant audits. Much more than a simple management tool, the audit (ever more when internal) allowed PAC team to develop a deep knowledge of the way they operate, in a transverse manner, which resolved problem of knowledge and competencies management

between staff members. These transparency and communication policy have also been demonstrated to users which helped them to build confidence in CINES services.

Conclusion

A quality approach for a sustainable digital preservation represents a significant investment over the long term, culminating in certification. It's also a lever in terms of transparency and communication. With this approach and these certifications past, CINES is now ready to be certified. The relevant standard was identified and even tested: the ISO 16363 published in February 2012 covers exactly the scope of PAC activities along with the visibility of an ISO standard. Therefore, CINES is waiting the release of an associated standard (ISO/DIS 16919) that will enable auditors certification, so that they are able to certify repositories in return, on the basis of the ISO 16363.

Following this experience, PAC staff members share their expertise with the rest of the community in lectures or participating in working groups in the area of certification. As an example, CINES is responsible for the working group on certification in the European project EUDAT (2011-2013). This project is twofold: it is both to define best practices for long-term preservation of scientific data and to implement a distributed infrastructure for sustainability data to meet the needs expressed by communities of researchers. Discussions also take place in the APARSEN project, an initiative from the European Commission, which started in 2010 to promote the rollout of a framework for the audit and certification of digital repositories, and for which PAC tested the ISO 16 363. This framework wants to federate the different accreditation and certification project into three levels of recognition of the quality assurance effort done by institutions in charge of the preservation of the digital heritage, in increasing trustworthiness:

- ✓ Basic Certification through the Data Seal of Approval (DSA);
- ✓ Extended Certification through DSA plus additional publicly available self-audit with an external review based on ISO 16 363;
- ✓ Formal Certification after full external audit and certification based on ISO 16 363.

These guidelines are part of a will to sharing, at European level, requirements for certification of trusted digital repositories. This helps to improve visibility with governing bodies, customers and user communities and can also be used as criteria for future funding.

In any case, certification standards are a great resource for archivists who don't have yet a digital preservation system but would like to implement it. Indeed, a quality assurance approach based on certification prerequisites can be a guide for those who wish to establish a long-term digital preservation service. By providing a list of requirements, a certification frame of reference can help to the drafting of specifications.