This document aims to describe O3-DPACS functionalities and the philosophy behind its development. For any additional information write to info@o3enterprise.eu.
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COMPANY OVERVIEW

O3 Enterprise is a University of Trieste Spin-off company that was born in January 2008. It was promoted and created by the Bioengineering and ICT group at the University of Trieste, founded by Professor Paolo Inchingolo. Its main objective is to accompany the project O3-Consortium (www.o3consortium.eu), that is maintained and managed by the same group under the umbrella of the Higher Education in Clinical Engineering (HECE) O3 Enterprise offers professional services and innovative solutions for the e-health based on O3 Consortium products.

The approach that distinguishes the O3-Enterprise’s solutions is to prefer, where possible, Open Source software and only consolidated standards for communication and integration with other systems.

O3 Enterprise won the local competition for innovative business ideas, called Start Cup 2007, and in April 2008 ITAL TBS SPA, a European leading company in clinical engineering services, joined its capital.

INTRODUCTION

This document aims to describe the features of O3-DPACS that is part of O3 Consortium open source suite. The services on this system offered by O3 Enterprise are even included in this document.

Actually the systems that compose the O3 Consortium suite are:

- A PACS (Picture Archiving and Communication System) system, named O3-DPACS (O3-Data & Picture Archiving and Communication System), which is able to store and manage all kind of DICOM data and images;
- A workstation system, named O3-RWS (O3-Reporting WorkStation), which is able to show the DICOM data and images contained in a PACS system. It offers numerous tools for evaluate the data and create the report;
- An endoscopy system, named O3-Endoscopy, which is able to acquire and manage endoscopic images and video clips.

COMMON FEATURES

O3 Consortium products are distinguished for the following strengths:

- **Scalability**
  O3 systems can be installed either on a simple laptop or on complex hardware infrastructure, including cluster systems.

- **Open Source**
  O3 systems are Open Source and covered by GPL licence.

- **Open Standard**
  All communications lay on open and consolidated standards, as DICOM and HL7.

- **Interoperability**
O3 systems are inspired by IHE (Integrating the Healthcare Enterprise) philosophy and most of them are fully compliant with the guidelines provided by this initiative.

- **Internationalization**
  O3 systems are easily translatable for an international use. Currently the available languages are English and Italian.

- **Portability**
  The use of Java technology and Web solutions allows total independence from the operating system and hardware configurations. There is therefore no choice forced by the user, but the products are adapted to individual needs.

- **CE Marking**
  All O3 systems are covered by CE mark.

- **Online Demo**
  All O3 systems are freely testable on the Internet, through O3-Consortium web site at www.o3consortium.eu.

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# O3-DPACS SYSTEM

## INTRODUCTION

O3-DPACS is a PACS (Picture Archiving and Communication System) extended to all types of data and signals that can be managed through DICOM protocol. It is the latest evolution of the DPACS system, born in 1996 thanks to the Group of Bioengineering and Information Technology of Professor Paolo Inchingolo. The goal of this system, inserted into a larger project from the same name, was to create a basis for developing an Open Source, scalable, low cost and universal system to save, manage and provide all the health’s information of every European citizen, thus offering an EHR of European level.

In 2004, the DPACS project was completely re-projected and DPACS 2004 was born. This new system aimed to apply the huge know-how acquired in several years of DPACS project to the new technologies and frontiers of the medicine. The following year DPACS 2004 has been included in the O3 Consortium project.

## ARCHITECTURE

The O3-DPACS system is based on the following software architecture:
APPLICATION SERVER

The application server used by O3-DPACS is the latest stable version of Jboss, 4.2.3GA. Jboss is one of the most popular Application Server, completely Open Source and now used by many manufacturers of worldwide fame. Its strengths are the ongoing updates, thanks to a very big community of developers, and especially the configurability and robustness, which makes it ideal to support Enterprise applications, including medical ones. The Application Server uses the JDBC (Java Database Connectivity) to connect to the database. The use of such architecture allows O3-DPACS to connect to all types of database servers that have JDBC driver, making the product highly configurable and adaptable to different needs.

O3-DPACS was also successfully tested on SUN official Application Server, named Glassfish. Any Application Server is supported used. This makes O3-DPACS even more configurable and adaptable to the needs of the user.

JAVA VIRTUAL MACHINE

The Java Virtual Machine is the main support of O3-RWS, since the application is developed in Java and requires this layer to work. The choice of this technology was driven by the Java ability to be independent from hardware and software sub layers. This technology makes the application usable on every hardware configuration and also on every Operating System. This allows the user to adapt the system to its needs without constraints.

OPERATING SYSTEM

Relying entirely on Java technology, O3-DPACS is completely independent of the type of Operating System. In several installations has been a fairly balanced use between Windows and Linux systems (Red Hat in particular).
DATABASE

The database server used by O3-DPACS is MySQL Enterprise. Following the philosophy of O3 system, MySQL is also completely Open Source, which makes it suitable for use in all contexts. Since the database is one of the most critical pieces of the entire architecture because it contains most patient data, it was chosen to use the Enterprise solution, in particular the Silver one, which offers more guarantees. O3-DPACS was also tested on Postgres database with good results. In any case, the use of JDBC driver for connections makes the application independent from the database, thus providing an excellent ability to adapt to the user needs.

STORAGE

The storage module of O3-DPACS deals to save images physically on the archives. Because this service uses Java technology, is totally independent of the type of hardware architecture. O3-DPACS could be installed in NAS (Network Attached Storage), SAN (Network Attached Storage), DAS (Direct Attached Storage) and CAS (Content Address Storage) hardware configuration.

A typical Hardware configuration is SAN-based and provides excellent security and good performance. It is shown in the following picture:

![Figure 2: Suggested hardware architecture](image)

THE MODULAR STRUCTURE

O3-DPACS is designed to be very modular, in order to enable or disable functionalities where they are required. This feature is essential to easily adapt the system to changing needs. The core is made of the
modules that handle basic services necessary to manage DICOM objects. Through these modules it’s possible to save, query and retrieve data. All O3-DPACS modules are shown in the following figure and in the next few chapters are described in detail:

![Figure 3: O3-DPACS modular structure](image)

**DICOM/HL7 MODULES**

**STORAGE**

The storage module is responsible for receiving and storing all DICOM objects that are sent to O3-DPACS. Usually these objects are sent from the modalities or reporting workstations. Once received an object, O3-DPACS extracts the information included in the DICOM header and it checks if these data are already present in the database. If the control succeeds, for security reasons, images are refused. Otherwise O3-DPACS continues the storage procedure, populating the database with the information.

For security reasons, whenever O3-DPACS receives DICOM object, unique imprint is computed and saved on the database. In this way it is possible to control if images are edited or modified after the storage procedure. This check is done to increase the security level.

For a complete list of accepted DICOM SOPClassUID, read the O3-DPACS DICOM conformance statement.

**QUERY/RETRIEVE**

The Query / Retrieve module allows to query the PACS through DICOM protocol. O3-DPCs supports every level of DICOM queries: patient-level (Patient Root), and Study/Series/Instance level (Study Root). The retrieve service is done through a DICOM move operation. The same service can be used for sending objects between two nodes, both for consulting and backup. The complete list of query fields and other technical info are described in the O3-DPACS DICOM Conformance Statement.
For security reason it is possible to limit the query results, separate them between the wards that created the objects. In this way it is possible to decrease the risk of improper accesses to the patient personal data.

<table>
<thead>
<tr>
<th>MODALITY PERFORMED PROCEDURE STEP</th>
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<tbody>
<tr>
<td>The MPPS module allows receiving MPPS messages, sent from modalities or other DICOM nodes. MPPS messages are essential to track the status of exams, so that PACS and RIS keep themselves updated on the ongoing processes. MPPS messages can be used in two ways. They can be forwarded to one or more RIS systems. Or they can update the status of the internal worklist. If an exam is in progress, in fact, should be no longer present in the worklist. The O3-DPACS DICOM Conformance Statement contains all the technical information on the module functionalities.</td>
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<tr>
<th>STORAGE COMMITMENT</th>
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<tbody>
<tr>
<td>The Storage Commitment module is fundamental for legal issues. The DICOM storage communication is in fact not enough to ensure a well done saving process on the PACS. It is necessary to have an additional feature that is the DICOM Storage Commitment message. It should be next to a storage procedure. When O3-DPACS receives the Storage Commitment request, pulls the file from storage and creates its unique imprint. If it matches with the one contained in the database, this means that the storage was done successfully. So O3-DPACS replays positively. If negative, it means that during the storage procedure something has gone wrong and it is necessary to store again the object.</td>
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<tr>
<th>WORKLIST PROVIDER</th>
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<tr>
<td>The worklist service is used to provide the worklist, usually for the modalities. The worklist service is necessary to avoid entering patient information on modality side. So the risk to generate errors and inconsistencies through the systems decreases drastically. Usually this service is provided by RIS. If the feature is not working, O3-DPACS can substitute to it, acting as a worklist dispatcher. O3-DPACS generates worklist by receiving messages from the HL7 interface. These messages must be formatted in accordance with the “Filler Order Management” transaction, included in the IHE (Integrating the Healthcare Enterprise) Scheduled Workflow Profile. The worklist are cancelled when an exam is done, hence receiving the appropriate MPPS message.</td>
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<tr>
<th>HL7 SERVER</th>
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<tr>
<td>The HL7 server handles HL7 communication with administrative systems. The server is able to receive all kinds of HL7 messages, but only those of interest are managed. O3-DPACS currently uses only messages for patient and order management. Regarding the patient management, O3-DPACS is totally conforming to the “Patient Information Reconciliation” (PIR) profile of IHE. This type of HL7 messages are used to modify the</td>
</tr>
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</table>
patient data contained in O3-DPACS in order to keep consistency between different archives. An example is when an exam is done for an unknown patient, e.g. in emergency. Regarding worklist management, HL7 messaged are used to populate the worklist, following the IHE Scheduled workflow profile (SWF).

REPORTING

The reporting module is very useful when the reporting processes are fairly complex and involve many clinicians that work at the same time on the same data. This module is based almost exclusively on the IHE Reporting Workflow profile (RWF). Once received a DICOM object, O3-DPACS is able to create a Reporting worklist similar to that used for the modalities. In this way, with an appropriate DICOM client such as O3-RWS, it is possible to query the list of reporting worklist. This allows tracking and managing all the reporting activities and preventing that the same exam is reported simultaneously. The information about the status of each reporting task are propagated through MPPS messages, which in this particular case are named General Purpose Performed Procedure Step or GPPPS.

FORWARD

The Forward module makes sure that all exams sent to O3-DPACS, can be forwarded to other storage systems. This feature is useful if images should be stored on multiple archives. The forwarding module is able also to move studies to other archives, following configurable time rules. This feature is very useful if it is necessary to synchronize PACSs, e.g. used as "cache" systems, with a central PACS. It is possible to configure the system in order to perform the operation during the night, when the network is less congested.

CORE MODULES

COMPRESSION

The compression module handles file compression and decompression process, with the intent to reduce physical space in the storage media and network bandwidth, e.g. in tele-radiology applications. For each DICOM node O3-DPACS connects to, it is possible to enable or disable the compression. When an image is received, this causes that:

- If the image is compressed, O3-DPACS saves it without modifications;
- If the image is not compressed, O3-DPACS compresses it before saving it physically;

In the case of a retrieving request from a workstation, before sending the images, O3-DPACS checks if the client supports compressed communication. If so the images are sent even compressed. Otherwise they are decompressed. It’s possible to force compression for outgoing images if the available bandwidth is limited. The compression algorithms currently enabled on O3-DPACS are the JPEG and JPEG 2000, both lossless.

ANONYMIZATION
O3-DPACS has been designed to be a useful tool for scientific and educational purposes. For this reason it have been implemented some tools for data anonymization. This feature, once enabled, replaces patient name, surname and date of birth contained in the DICOM header with other info. This could be done both for outgoing and ingoing data. The patient ID field remains unmodified, in order to permit data tracking. This tool allows creating databases of clinical data useful for educational or scientific scope without issues for the privacy and the personal data protection. Important feature that has been added to this service is the anonymization mask. In fact some images show the patient’s information directly on the image pixels, e.g. old ultrasound images. In case textual anonymization is not enough. To overcome this issue, O3-DPACS offers a masking tool that can be applied to those images, hiding the patient information. This mask is completely configurable for each O3-DPACS node. The figure below shows this useful procedure:

![Images' anonymization procedure](image)

**WEB MODULES**

**CONFIGURATION TOOL**

The configuration tool allows the administrator to modify O3-DPACS runtime parameters to optimize the system features. Any O3-DPACS parameter can be changed in order to adapt it to every environment. Since the tool is provided by web interfaces everything can be changed remotely, thus making unnecessary a physical intervention to O3-DPACS server.

**ADMINISTRATION TOOL**

Through the administration tool O3-DPACS nodes, storage area and users can be managed. Everything is done through a web interface, in order to avoid physical intervention on the O3-DPACS server.

**WADO SERVICE**

The WADO service (Web Access to DICOM Object) is important to facilitate integration with other systems that should work closely with O3-DPACS. WADO service is provided by DICOM standard. It allows receiving a preview of the data contained in the PACS system, after a HTTP request. In the case of images, the preview is sent in JPEG lossy format in order to speed up the transmission. Many other formats are supported. For example, in the case of multi-frame images, the preview is sent as a QuickTime video clip; in
In the case of Structure Report, the preview is a PDF document. O3-DPACS-WEB heavily exploits this service to provide a comprehensive view of data contained in O3-DPACS.

To increase security, it has been provided HTTPS support with mutual authentication, so that only authorized users are able to view patients’ data.

**SPECIAL MODULES**

Beside standard modules, it has been added some special modules for different needs. These modules are:

**XDS-I**

This module behaves as a Document Source, as defined in the IHE Cross Enterprise Document Sharing profile. XDS is a Document Registry/Repository that aims to provide a common infrastructure for sharing documents, even medical, between different enterprises. XDS-I is an extension of XDS, namely "for Imaging" which provides a standard method of publishing PACS images on a XDS system. O3-DPACS has been equipped with this feature. When an image is received, O3-DPACS communicates with the XDS system in order to publish it. For more information, see the IHE Technical Framework.

**BACKUP AND LEGAL ARCHIVIATION**

The Backup System integrated in O3-DPACS has been designed for two purposes. The first is to move data from PACS system to storage or backup systems. This feature can be used both for disaster recovery and long-term storage. The second purpose is to store data according to the latest regulations for legal archiving. Through this tool, completely configurable according user needs, it is possible to sign up the data contained in O3-DPACS and create volumes that can be burned to optical media or to WORM (Write One, Read Many) systems.

**O3-DPACS-WEB**

O3-DPACS-WEB is the new O3-DPACS’ web interface. Its main feature is to let the user to browse the data contained in O3-DPACS. This feature is suitable for wards distribution of data, as well as for teleconsulting and remote reporting. The data are shown basically with a preview that, in the case of images is JPEG lossy format. The tele-consulting tool allows retrieving original data and using them for clinical purposes.

The first window is the login page. Actually four categories of users been have been implemented, each of them with different levels of security:

- Administrator, who is able to open any DPACS-O3-WEB page and also configure and administer O3-DPACS;
- Super User, who is able to see data previews and to manage O3-DPACS data, in order to add/modify/delete nodes or storage area. Regarding user management, the Super User can only
change or add users for lower security levels. The Super User is typically an IT manager or ward responsible. This user can also delete exams or modify/unify patients’ records.

- Physician, typically radiologists working remotely, who is able to view data preview and to download O3-RWS Workstation to view the original ones for reporting or second opinion/teleconsulting purposes.
- User, who is able to view previews of the data contained in O3-DPACS.

The main interface of O3-DPACS-WEB is shown in the figure below:

![Figure 5: O3-DPACS-WEB Main Screen](image)

“PACS CONTENT BROWSER” SECTION

The section allows searching the patients’ studies through the interface shown in the following figures:

![Figure 6: Search Form](image)
Each study found is represented by a row. On each of them it is possible to:

- View a list of the series associated to the selected study;
- Delete the selected study. This feature is limited to Super Users or higher groups;
- View the original study with O3-RWS. This feature is limited to Physician or Administration users.

The window that shows the series list is the following one:

Each series can be removed, e.g. if there have been mistake in the acquisition process. Going further, it is possible to view previews of each DICOM object, through WADO protocol. The interface provides basic tools for operations on images such as zoom, pan and Window / Level. The figure below shows the interface for viewing images:
“STUDY/SERIES RECOVERY” SECTION

The section provides a list of all the cancellations performed on the web interface. It is possible to restore them in the case of an erroneous deletion. Further information on this feature is described in the next sections.

The interface for this feature is the following:

![Recovery screen](image)

“DICOM NODES MANAGER” SECTION

In this section, which is part of the O3-DPACS Administration tool, it is possible to manage all DICOM nodes that connect to O3-DPACS. Also storage area, on which the images are stored in, can be managed. The figure below shows the nodes management window:
Figure 11: Nodes management window

“USER MANAGER” SECTION

The user management section, which is part of the O3-DPACS Administration tool, allows users management. The figure below shows this interface:

Figure 12: Users Management window

“ADMIN AREA” SECTION

This section allows managing and configuring O3-DPACS. It appears as shown in figure below:

Figure 13: Administration page

The first button allows activating or deactivating O3-DPACS DICOM services. The second is used to enter the configuration module. The third allows O3-DPACS runtime parameters monitoring, through graphic interface, e.g. for RAM occupation.

TELERADIOLOGY TOOL
Since the images displayed on O3-DPACS-WEB are not intended for diagnostic purposes, because they are in jpeg lossy format, O3-DPACS-WEB let the user to download the original ones. Web interfaces for image processing are always complicated, not user friendly and do not support multimonitor capabilities and do not use all hardware features. For overcoming this issue, O3-DPACS has been closely integrated with the O3-RWS, the O3 Reporting Workstation. From the O3-DPACS-WEB study list, it is possible to open O3-RWS through Java Web Start technology. Automatically data are opened in the viewer panel of the workstation, in order to start as soon as possible the reporting process. It is important to underline that the communication between O3-RWS and O3-DPACS is done not through standard DICOM but through WADO protocol. In this way it is possible to overcome the needs of a static and public IP address for receiving images.

The tool can be used from any computer and any type of connection. Through https secure connection is even unnecessary to create dedicated VPN.

O3-RIS

The O3-RIS module allows basic management of patient registration, exam request, booking and management.

The module layout is completely different from O3-DPACS one. The welcome screen is shown in the figure below:

![Figure 14: O3-RIS Login Interface](image)

The O3-RIS module is characterized by the following sections:

**PATIENT MANAGEMENT**

O3-RIS allows adding patients and editing their information through the interface shown in the figure below:
Once added the patient or selected one, it is possible to create an order for it, as illustrated in the following figure:

**ORDERS MANAGEMENT**

Once the order is created, O3-RIS shows the interface for scheduling. For each modality there is a list of available slots. It is possible to schedule the order in one of the slots. The following picture shows this interface:
WORKLIST MANAGEMENT

It is possible to manage order worklist and to open O3-RWS once exam is done. The figure below shows the worklist management window:

ATNA

According to the recent legislation on privacy and personal data security, it is essential to trace all actions that are made to the personal data of subjects. Traceability is often confused with logs, and that, while theoretically allows reconstructing a history of actions made on patient personal data, on the other most of them are so complex and heavy that makes a critical reading very difficult (in some cases impossible).

O3 Enterprise wanted to focus on that aspect to bridge this gap in the today IT market in healthcare. Most systems on the market today do not allow an easy management of logs, thus making almost impossible tracking data. Other vendors offer completely proprietary solutions that while satisfying the punctual need, preclude the comprehensive one. Indeed proprietary systems do not allow, unless expensive and not always successful manipulation, integration with other systems thereby making the research of patient’s history limited to the individual application, thus not allowing a uniform comparison.

O3 systems address this problem through the latest technological solutions on the market and have identified IHE’s ATNA as the best solution to ensure traceability and security of communications and data.

ATNA PROFILE
The ATNA acronym stands for Audit Trial and Node Authentication and it is the solution proposed by IHE to keep track of personal data and to ensure a secure communication between nodes. Graphically the profile can be summarized as follows (from the official site IHE):

![Figure 19: ATNA functionalities](image)

The main characteristics of the profile are:

- **User Authentication**
  The profile requires that each user, before running an application in an ATNA environment, should log in. Once it is authenticated, its work can be traced over the network. IHE does not provide any authentication systems. The way of authenticate the user is up of individual vendor and user.

- **Remote Node Authentication**
  A very important thing is to ensure that only authorized nodes can have access to patient data. The systems should be configured to accept connections from those authorized nodes and refuse connections from unknown client. Unfortunately in the case of radiology, the dialogue between different nodes, via DICOM protocol, does not offer many guarantees. In fact DICOM provides only an IP/Application Entity Title filter. This does not guarantee an unwanted access to personal data contained in the server. To overcome this limitation, ATNA provides a type of authentication based on mutual exchange of digital certificates. PACS must have an updated list of authorized clients’ certificates. Before every connection, there should be an Acknowledgment procedure in which the certificate offered by the client is compared with those on PACS’ list. If the check success, the communication can continue, otherwise it stops. The same procedure can be used with the client that should controls PACS’ credentials.

- **Secure Communication**
  ATNA suggests that all the nodes should use secure communications in order to protect data while sent on the network. The way to ensure this is to create an encrypted TLS tunnel between DICOM
nodes. This secure communication, provided by DICOM standard, is named DICOM TLS. O3 systems provide to set up secure communications with credential check.

- Tracking Communications

To keep track of all actions that take place within a secure ATNA environment, it is required an Audit Log server. ATNA provides a set of events driven messages that should be sent to a Audit Log Repository. These messages should contain information about the action performed, the date and time, the user that has generated it, the owner of the personal data, the nodes involved and other useful information. Through appropriate interfaces, on the Audit Log Repository it is possible to track every action and carry out statistical analysis on each event.

### ATNA IN O3-DPACS

O3-DPACS, like all other O3 products, is IHE compliant and that fact has been tested during the IHE Connectathon. This is an event in which health IT systems producers test mutual communication.

As for DICOM node authentication, O3-RWS is configured to exchange certificates for every connection and then authenticate remote nodes. This feature is not limited only to dialogue between O3 applications but can also be extended to other actors involved in the workflow.

O3-DPACS can be configured to send audit log messages to an IHE Audit Log Repository. These log messages are sent every time a transaction on patient data is done. The collection of all this information from all nodes in the workflow, ensure traceability according to the latest legislation.

In addition, O3 Enterprise can offer an Open Source Audit Log Server, properly configured and adapted to the particular needs of the customer.

### AUTHENTICATION SYSTEMS

O3-DPACS is a system that does not interact graphically with users and therefore has no need of authentication systems. To avoid unauthorized access, there is a security control on the nodes that connect to O3-DPACS. This control is done through certificates exchange and an acknowledgement between nodes, prior to send images. Only certificates contained in o3-DPACS list are accepted.

For O3-WEB-DPACS, that offers a graphical interface to the user, it is proposed both local authentications, by typing username/password and database, and remote authentications via LDAP system. In each of them, there are few users’ categories:

- Administrator, who has access to all sections and can also change O3-DPACS settings;
- Super User, who has access to all sections except those for the administration of O3-DPACS; it cannot view original images.
- User, who has the opportunity to see the preview of data contained;
- Physician, who can see data previews and download O3-RWS for the original ones. This is suitable for remote reporting or second opinion/teleconsulting.
O3-DPACS is designed to provide high level protection of the data contained in it. The objects that it receives should remain unchangeable in order to avoid loss of information or their modification. Many security checks have been implemented. The first security check regards that O3-DPACS is unable to save DICOM objects with the same ID twice. If a node sends them to O3-DPACS and they are already present, they are refused and the node receives an error message. This avoids overwriting the objects, thus keeping information unmodified.

The second security check regards objects fingerprint. To avoid errors in the storing procedure, O3-DPACS creates the fingerprint (Hash) of every objects received, saving it on the database. If the DICOM node sends a Storage Commitment message, O3-DPACS pulls images from the file system, generates the fingerprint and compare it with that contained in the database. If the two objects match, it means that the objects were saved without errors. And O3-DPACS replays with a positive message. Otherwise, it means that there have been problems during storing procedure and the DICOM objects should be sent again.

Also the database and storage area offers other security checks. Only authorized users, typically system administrators, are able to access the physical media. Users will not have the capabilities to write, change or read objects.

Another security check is implemented in DPACS-O3-WEB. In fact, as explained before, both Administrators and Super-users have the permission to delete studies, series or instances, trough the web interface. This feature has been implemented to overcome the ID security check. If fact if an erroneous data is stored it is impossible to save the correct one because sometimes its ID remains the same. And O3-DPACS refuses it. So it is possible to delete wrong data in order to send them again. For security reason, when the user delete data, O3-DPACS only change some fields in the database, as the object ID. All modifications are collected in a recovery table, shown in the following figure:

![Recovery Interface](image)

Each line corresponds to a delete operation. The interface shows the user that did the operation, the date and time, who the data belong to and the reason. Through this interface it is possible to restore all data to
the state prior the deletion process. Obviously system keeps track of this, integrating the recovery record with the information of who restored it and when this happened.

SYSTEMS ACCOMPANYING THE SUITE

VOICE RECOGNITION

To facilitate the work of the specialist during the reporting activity, O3-DPACS was designed to be integrated with the most common and well-performing voice recognition software, in particular those provided by Philips and IBM. Theoretically, each text box in this application may be filled through the use of voice rather than the classic keyboard.

Moreover, to facilitate the use of applications in a clinical context was introduced the possibility of controlling and managing some basic functionality through voice commands. Other types of controls can be agreed with the client.

The instruments recommended and integrated with O3 systems are:

| Figure 21: Handheld keyboard | Figure 22: Headset | Figure 23: Wireless Headset | Figure 24: Bluetooth Headset |

PRINTING AND BURNING PATIENT CDs

On O3-DPACS is also featured a tool that allows to create Patient CDs. This tool follows closely the Portable Data for Imaging (PDI) profile of IHE. This profile explains how to create a CD with a standard structure, so that other systems are able to open it.

O3-DPACS creates CDs with the following files / folders in the root directory:
The DICOMDIR file contains references to DICOM images saved in the media. The README.txt file contains information about who created the CD/DVD. To facilitate the patient in viewing images and reports, a simple website with all images in JPEG lossless format is included in the CD/DVD. The website layout, accessible through the index.htm file, is configurable and can be modified by the user. On the CD there is also the O3-RWS workstation, in order to view original images and perform “image processing” operations if necessary.

The burning process is done through local drives on the PC where O3-DPACS is installed. It is possible to provide a central burning server that O3-DPACS connects to. Actually O3-DPACS is integrated with the Rimage systems, in particular with the RIMAGE 2000i, shown in the figure below:

Using this solution, the labels to be printed on the CD / DVD can be easily designed, in order to adapt them on customer’s needs.

**STANDARD AND INTEROPERABILITY**
Particular emphasis was placed on protocols chosen to save and communicate image and data. O3 Consortium pursues the vision that standards and open formats are an added value of the whole system, allowing an easy integration with other operating systems.

Starting point for a system that aims to be interoperable and flexible is the use of open and totally transparent communications. That is the philosophy that guides the development of O3 solutions, avoiding any kind of proprietary communication and preferring only standard and well-established protocols.

**IHE**

O3 Consortium was born and continues to operate with the idea that standard and especially interoperability are the most important things in modern IT system management. It came natural to move to move towards the vision of the “Integrating the Healthcare Enterprise” (IHE) project. The IHE vision is widely shared by O3 systems and it is the basis for all products development. In the design phase, they are not regarded as systems but as IHE actors.

O3-Enterprise, following this focus, made interoperability its mission.

The main profiles/actors that have been implemented in O3 solutions are listed below:

**SCHEDULED WORKFLOW PROFILE (SWF)**

The Scheduled Workflow profile ensures cooperation in the radiological workflow. It manages orders, reservations, images acquisitions, storage procedures and the display of radiological images.

![Figure 27: Scheduled Workflow Profile](image)

**PATIENT INFORMATION RECONCILIATION PROFILE (PIR)**

The Patient Information Reconciliation profile tries to solve some common issues in patient registration. It takes care of reconciliation of patient information through different systems inside hospitals. It is necessary
when the images were acquired but the patient is not jet identified (e.g. unconscious), or wrongly identified.

**Figure 28: Patient Information Reconciliation Profile**

**CONSISTENT PRESENTATION OF IMAGES (CPI)**

The Consistent Presentation of Images profile allows managing Presentation States objects that contain graphical information on how radiological images should be displayed.

**KEY IMAGE NOTE (KIN)**

This profile allows users to post interesting images (e.g. for reporting, surgery, etc.) and add notes to them, making more easily recognizable. This is very important for big sets of images, like multilayer CTs.

**AUDIT TRAIL NODE AUTHENTICATION (ATNA)**

This profile describes some of the security systems for authentication using certificates and sending audit events to a repository. This helps to implement policies of confidentiality.

**ACCESS TO RADIOLOGY INFORMATION (ARI)**

Access to Radiology Information, applied to Image Manager/Archive actor, specifies DICOM access to data within a single network, so that they can be found and recovered in a consistent way.

**CONSISTENT TIME (CT)**

This profile allows you to synchronize the time for all the hospital’s systems.

**CROSS ENTERPRISE DOCUMENT SHARING FOR IMAGING (XDS-I)**

It extends the XDS profile to share images, diagnostic reports and related information within a group of points of care (e.g. regional network).

**PORTABLE DATA FOR IMAGING (PDI)**
Portable Data for Imaging allows a reliable exchange of data, images and diagnostic reports on CD for the import, printing, or alternatively, the display on a browser.

**REPORTING WORKFLOW (RWF)**

This profile enables the medical staff, at any step of the complex process of reporting, to be monitored and organized so to ensure maximum simplicity and transparency, which are key requirements for obtaining a diagnosis complete, accurate and free of error, providing worklist, the status and the result of monitoring the reporting activities, such as dictation, transcription and verification.

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**REFERENCES**

O3-DPACS can already boast excellent references:

- **Azienda Ospedaliera di Padova**
  Since 2006 O3-DPACS manages all radiological exams of Azienda Ospedaliera and Clinica Universitaria di Padova (Padua Hospital): 150 nodes connected, more than 150,000 exams per year with more than 20 million images in the database.

- **Azienda Universitaria-Ospedaliera di Trieste**
  An O3-DPACS server is now installed in Radiology Unit and manages Unit’s requirements on images for research and teaching in order to create a network of research for multicenter anonymized data.

- **Azienda Ospedaliera e Università degli studi di Pisa**
  Two O3-DPACS servers have managed the imaging needs of hospitals Cisanello and Santa Chiara in Pisa since September 2005 at production level. The systems will be replaced with a O3-DPACS server for research purposes, in order to create a network of research for multicenter anonymized data.
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Demo Live
Connect to www.o3consortium.eu and test all O3 systems live.