

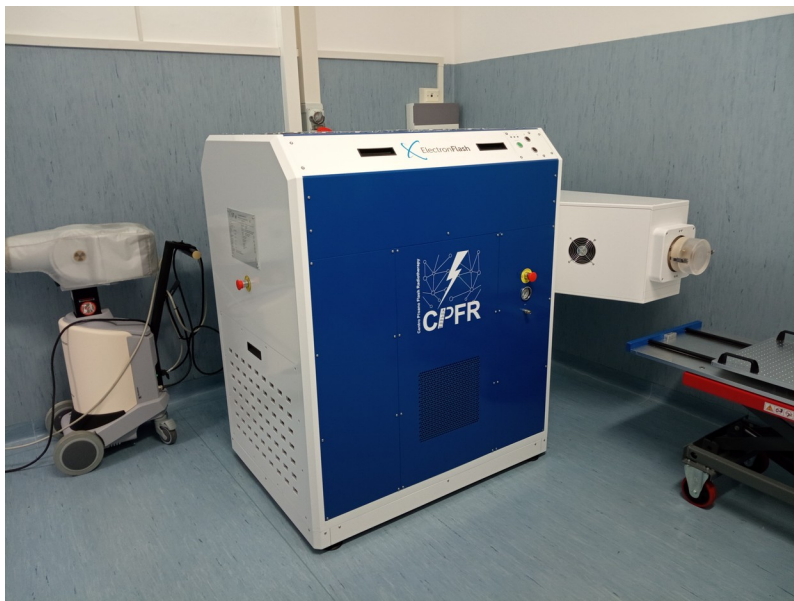
Setting up an open-source XNAT IT platform for medical imaging research



Progetto PNRR



THE
Tuscany Health Ecosystem



- THE “Flash Effect”
- Spoke leader: CNR
- Affiliated partners: UNIFI, UNIPI, INFN



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Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA

I soliti problemi...

- Gruppi multidisciplinari → requisiti specifici e comuni
- Dati clinici e immagini → Privacy, GDPR, ISO
- Processi e impatto sull'organizzazione
- Autenticazione e autorizzazione
- Gestione del ciclo di vita dei dati
- Condivisione e collaborazione
- Conservare la nuova conoscenza
- E così via...



XNAT

- What Is XNAT ?
- XNAT is an open source imaging informatics platform developed by the **Neuroinformatics Research Group** at Washington University. XNAT was originally developed at Washington University in the Buckner Lab, which is now located at Harvard University. It facilitates common **management, productivity, and quality assurance tasks** for imaging and associated data. Thanks to its extensibility, XNAT can be used to support a wide range of imaging-based projects.

What does XNAT provide?



Full DICOM Integration and Anonymization:
Get image data in, and keep PHI out.



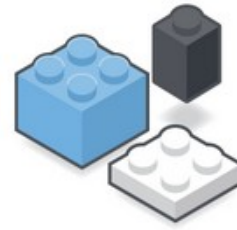
Secure Access & Permission Control:
You decide who does what with your data.



Integrated Search & Reporting: Report on your image and clinical data together.



Pipeline Processing:
Use the power of high-performance computing on your data.



Modular Extensibility:
Expand the capabilities of your XNAT to meet your needs.

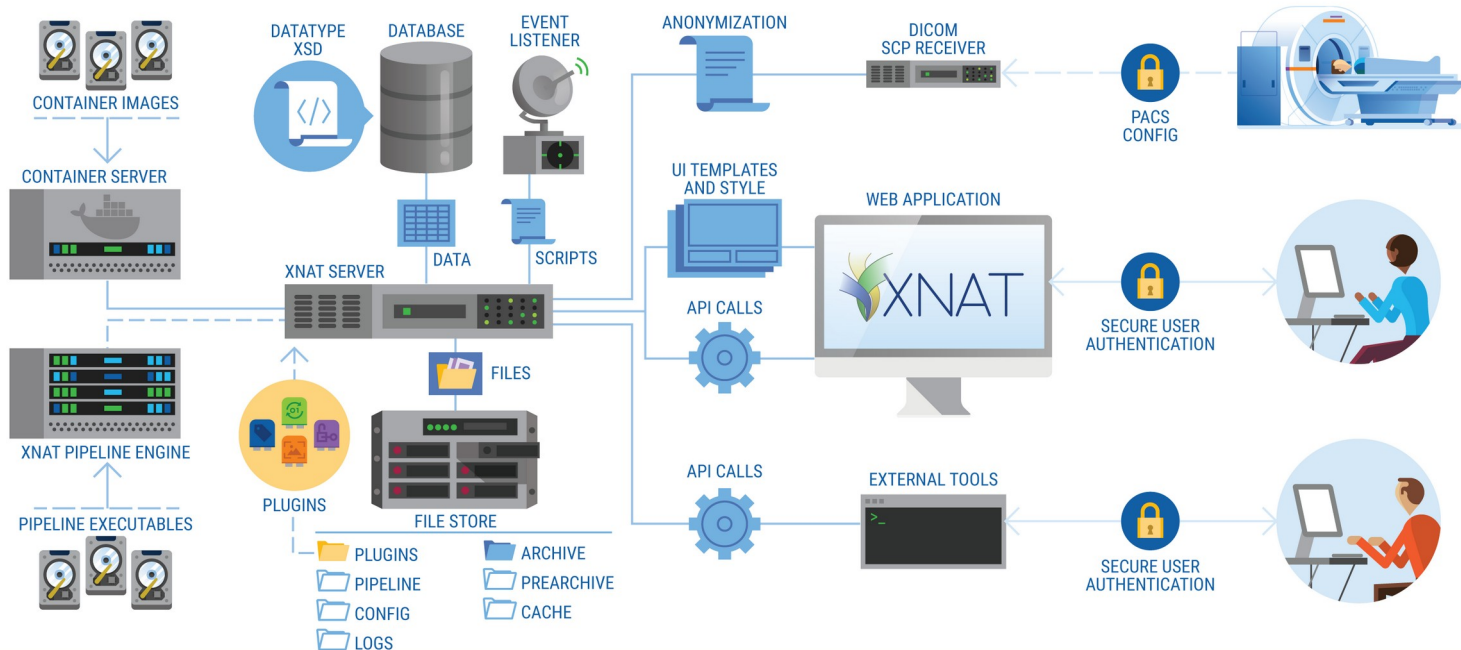


Developer Community:
Benefit from an active and engaged set of XNAT power users.

Understanding the Components of XNAT



FILED UNDER: GETTING STARTED



CONTAINER SERVICE

Run processing in containers where each container image controls its own environment. Enabled via plugin.

XNAT PIPELINE ENGINE

Run processing on XNAT data and return outputs to XNAT.

PLUGIN FRAMEWORK

Add data types, API, UI & features.

XNAT SERVER

Java-based web application on an Apache Tomcat server.

XNAT DATABASE

PostgreSQL used to store indexed project data according to defined XSD Schemas.

FILE STORE

All file resources are stored. Only the Archive should be backed up.

EVENT SERVICE & AUTOMATION

Script automated responses to user or system events.

ANONYMIZATION

DicomEdit scripts can be applied site-wide or on a per-project basis to remove PHI from DICOM headers.

FRONT END

UI is built in Velocity Script templates and delivered as HTML / CSS for use in a web browser.

API

Core data functions and commands can be accessed by external tools or scripts with proper authentication.

DICOM SCP RECEIVER

Allows your XNAT to be set up as a destination for PACS to send image sessions to. Requires PACS to be set up separately.

USER AUTHENTICATION

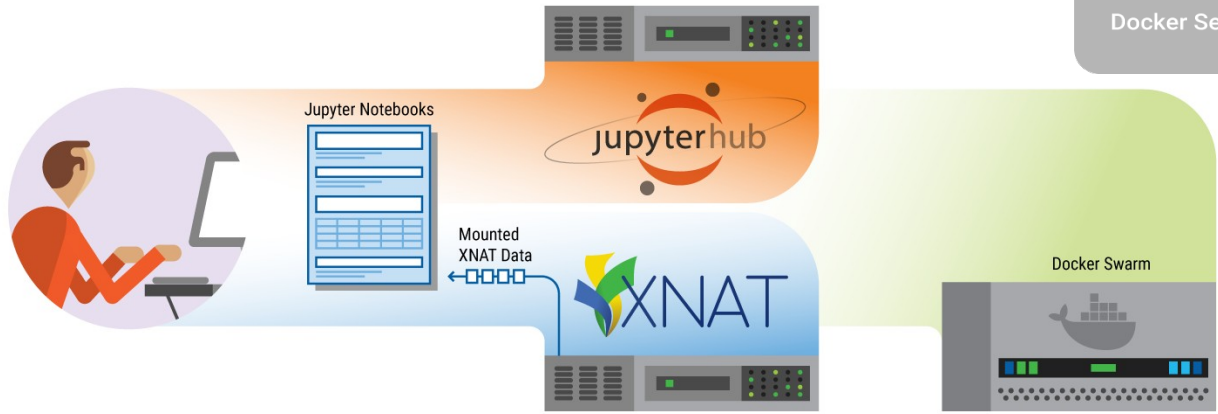
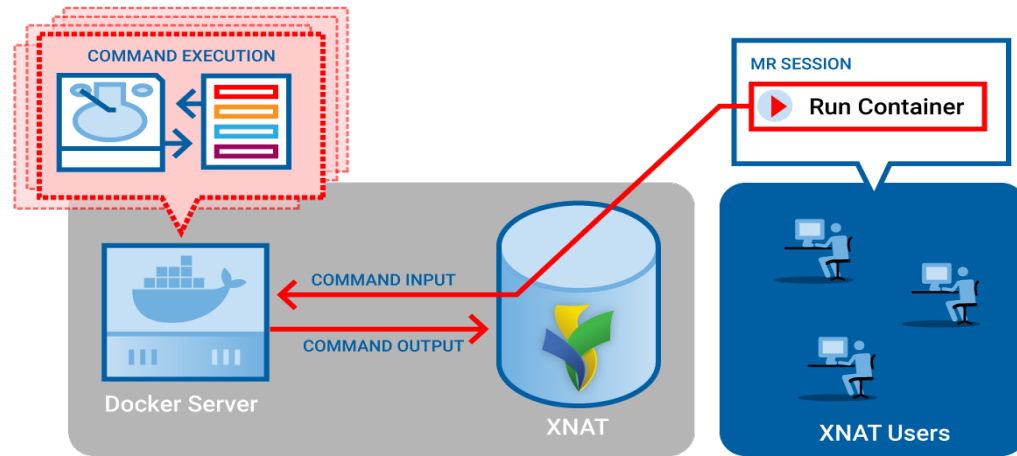
Spring Security used by default. LDAP / OpenID can be enabled by plugins.

USER ACCESS

Data access in XNAT is segregated by project. Each project determines who has access to its data. User access can be enabled or disabled by site administrators as needed.

Plugin

- XNAT Desktop Client (Mac OS, Windows e Linux)
- LDAP Authentication Plugin
- OpenID Authentication Plugin
- Container Service Plugin
- JupyterHub Integration Plugin
- XNAT OHIF Viewer
- XNATpy
- XNAT ML



Configurazione server XNAT @ INFN-Pisa

- **Macchina virtuale con GPFS a bordo**
- **Running XNAT in a Dockerized Container with Configurable Dependencies**
 - 1) `$ git clone https://github.com/NrgXnat/xnat-docker-compose`
 - 2) `$ cd xnat-docker-compose`
 - 3) `$ git checkout features/dependency-mgmt`
- **Inizializzazione web application**
- **Configurazione certificato ssl**
- **Configurazione plugin LDAP**
- **Configurazione Container Service plugin**
- **Configurazione OpenId connect plugin**
- ...

Configurazione (2)

```
xnat:~ # docker ps -a
```

CONTAINER ID STATUS	IMAGE	COMMAND	CREATED
PORTS			
NAMES			
f93d337e3b46 Exited (0) 18 hours ago	xnat/hello-world:1.0	"/hello"	18 hours ago
xenodochial_engelbart			
77b06e8d56cf Exited (0) 18 hours ago	hpc/wn-hpc2:cs7	"ls"	18 hours ago
eloquent_sammet			
ea8b7327757b Up About a minute	xnat-web	"wait-for-postgres.s..."	19 hours ago
0.0.0.0:8000->8000/tcp, 0.0.0.0:8104->8104/tcp, 0.0.0.0:8144->8144/tcp, 8080/tcp xnat-web			
e5ed2a1fd3b3 Up 19 hours	xnat-db	"docker-entrypoint.s..."	19 hours ago
5432/tcp xnat-db			
bd67689cb90f Up 19 hours	traefik:latest	"/entrypoint.sh --lo..."	19 hours ago
0.0.0.0:80->80/tcp, 0.0.0.0:443->443/tcp, 0.0.0.0:8080->8080/tcp xnat-traefik			

```
xnat:~ #
```

```
xnat:~ # ls xnat-docker-compose/xnat-data/plugins/
```

```
batch-launch-0.6.0.jar ldap-auth-plugin-1.1.0.jar
```

```
containers-2.1.0-fat.jar ohif-viewer-3.2.0-fat.jar
```

```
xnat:~ # ls xnat-docker-compose/xnat-data/
```

```
archive build config logs plugins tomcat webapps
```

```
xnat:~ # ls xnat-docker-compose/xnat-data/config/auth/
```

```
ldap-provider.properties
```

```
Xnat:~#xnat:~ # cat xnat-docker-compose/traefik/config/certificates.yml
```

```
tls:
```

```
certificates:
```

```
- certFile: /etc/certs/server.crt
```

```
keyFile: /etc/certs/server.key
```

```
xnat:~ #
```

```
xnat:~ # mmgetstate
```

Node number	Node name	GPFS state
6	xnat	active



Toy Platform for Phantom CT images

Details Access Manage Pipelines

ID: ToyPhantom
Description: Toy platform to try XNAT features to store CT images of phantoms.
PI: Scapicchio, Camilla

Edit Details

Delete

Manage Custom Variables

Actions

- Add ▶
- Add to Favorites
- Download XML
- Download Images
- Processing Dashboard ▶
- Manage Files
- Upload Images
- View Prearchive
- Project Settings
- Scan Type Cleanup

Subjects ×

Add Tab ▾



< prev

next >



<< first < prev **1** next > last >>

200 ▾

1 of 1 Pgs (4 Rows)

Reload

Options ▾

Subject	M/F	Hand	YOB	View	Phantom_name	Scanner	CTDIvol	kVp	ReconstructionAlgorithm	IterativePercentage	PixelSpa
CAT_fc18_2_aidrSTD	U				Catphan	TOSHIBA	2		AIDR3D	40	0.428
CAT_lung_2_asir10	U				Catphan	GE	2		ASIR	10	0.406
RAD_lung_4_FBP	U				Radiomik	TOSHIBA	4	120	FBP	0	0.781
RAD_lung_7_asir10	U				Radiomik	GE	7		ASIR	10	0.703

Scans XNAT Nav Layout Stack Scroll Zoom Levels Pan Reset CINE Annotations Tools Commands Tag Browser Contour Mask

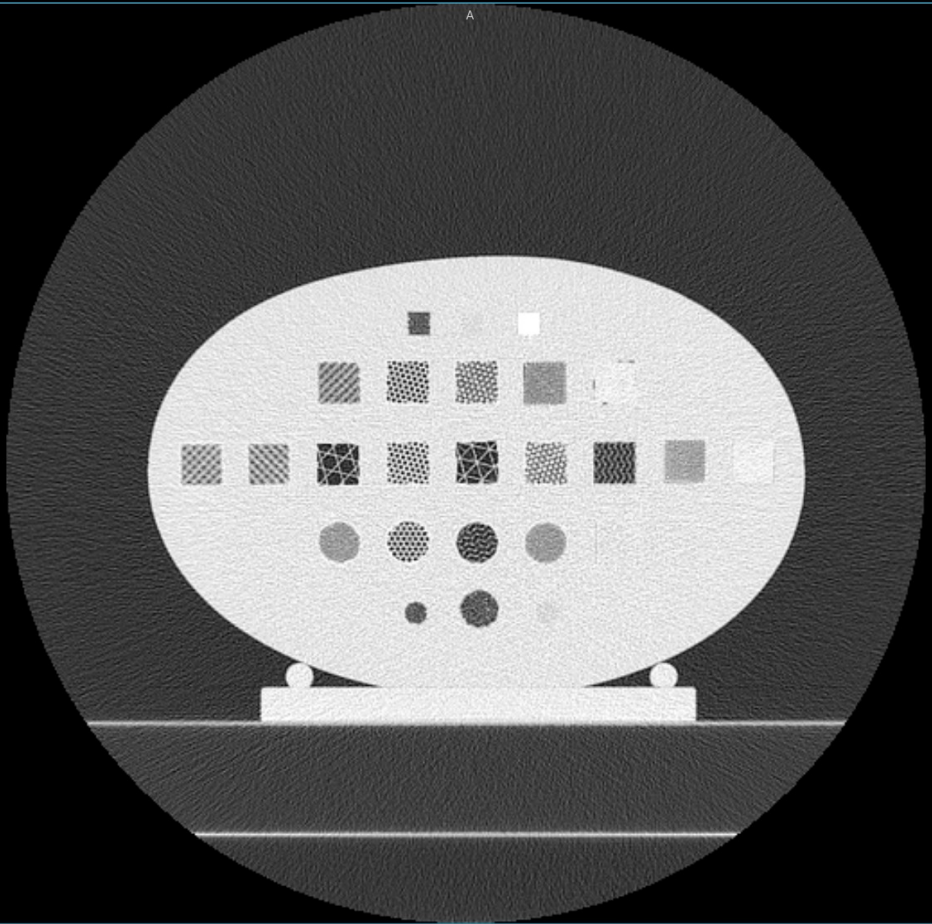
Contours Masks

ToyPhantom



XXXXXX-003
999999-003

R



CT
Ser: 9
Img: 79 37/79
512 x 512
Thick: 1.00 mm
Lung 1.0

ToyPhantom
Oct 31, 2023 13:40:13
Sync
Smooth

Zoom: 217%
W: 1600 L: -550
Windowing: Default
Lossless / Uncompressed

LDAP e la gestione dei ruoli in XNAT

- `ldap-provider.properties:`

`name=LDAP`

`provider.id=ldap`

`auth.method=ldap`

`visible=true`

`auto.enabled=false` → L'utente non deve essere automaticamente abilitato nel sistema !

`auto.verified=true` → La verifica può essere automatica, altrimenti il sistema invia una mail con link di verifica su cui l'utente clicca

...

...

The screenshot displays the 'Edit User Info' window in XNAT. The window is titled 'Edit User Info' and has a 'Close' button in the top right corner. It is divided into several sections:

- Details** (selected tab) and **Stored Searches** (inactive tab).
- User Details**:
 - Username: camilla
 - First Name: Camilla
 - Last Name: Scapicchio
 - Email: camilla.scapicchio@pi.infn.it
 - Verified: Yes
 - Enabled: Yes
- Actions** (dropdown menu):
 - Edit
 - View XML
- Assign project membership and roles**:
 - Project Label: Toy Platform Phantom
 - Project ID: ToyPhantom
 - Group: Owners
 - Buttons: Add Role, Edit, Delete
- Define security settings**:
 - System Roles**:
 - Site Manager : This allows users to access the Administrative pages of the web interface.
 - WARNING: Granting administrative privileges allows this user great power over the entire site.
 - Non-expiring : This prevents this accounts password from expiring.
 - WARNING: Granting a user account a non-expiring password is a security risk and should be limited to accounts that perform automated system tasks. In addition if any users are designated as non-expiring access to the user list should be restricted to administrators.
 - Allow All Data Access**:
 - No
 - Read Only
 - Read, Edit & Delete
 - WARNING: Allowing 'All Data Access' will allow this user to see ALL data stored in this system, superseding project membership. This permission is automatically granted to all site administrators, but should not be granted to most other users.
- Save** button
- Close** button

Federazione IDEM: OpenID Connect plugin

- Attualmente XNAT è agganciato al ramo (PI) di INFN-AAI;
- Configurazione plugin OpenID per XNAT è in corso, ringrazio Enrico M.V. Fasanelli per il supporto;
- È fondamentale garantire accesso a identità afferenti ad altri EPR e Università;
- `Openid-provider.properties`



“L’orchestra non ha bisogno del direttore durante le melodie ma nei momenti di ritmo.”

Riccardo Muti

Fin qui tutto bene ma a questo punto sarebbe possibile integrare XNAT nella nostra infrastruttura di calcolo scientifico ?

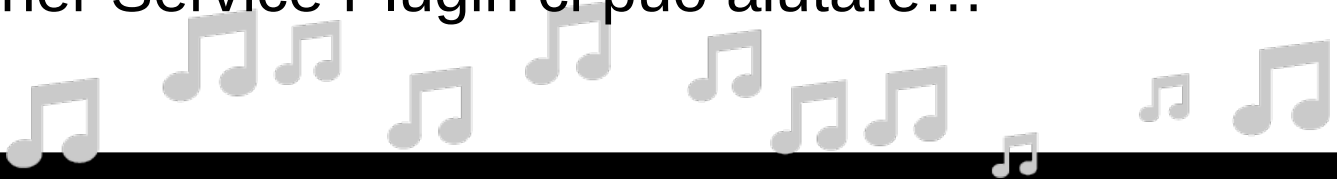
Pipeline Engine

- Java-based framework that links sequential activities, human and computer.
- In most laboratories, some processes (or pipelines) are carried out automatically without any human intervention while others require a person to do manual steps, such as drawing a region of interest.
- Pipeline Engine facilitates both fully automated and semi-automated workflows.
- The process flow is defined in an XML document called the pipeline descriptor and the executables are defined in a separate XML document called resource descriptors.
- Pipeline engine ships with support for Sun Grid Engine (SGE).



Idea

- E se il nodo xnat si trasformasse in una login user interface ?
- Possibilità di sottomettere job batch (container a scelta) verso una coda dello scheduler
- La pipeline in XNAT → upload automatico dei risultati dentro il progetto A (è un requisito irrinunciabile ?)
- Pro: uso ottimale delle risorse di calcolo e facilità d'uso
- Contro: immagine docker deve essere XNAT ready ? (complessità)
- Vediamo se il Container Service Plugin ci può aiutare...



Container Service

Settings for [Test-2](#)

Container Service

Configure Commands

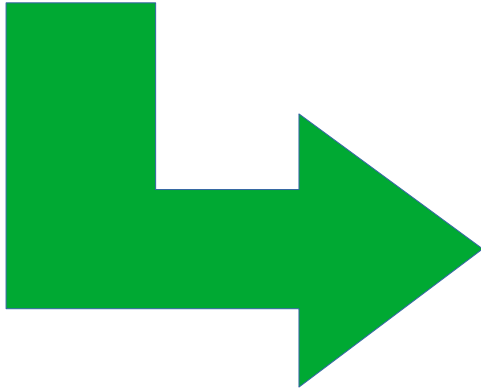
Command Automation

Command History

Project Command Configurations

i This panel lists all enabled commands from all installed images, and allows project owners to define a custom configuration for each command. This configuration will be used by default by all users in this project, but users can override certain parameters.

XNAT Command Label	Container	Enabled	Actions
Enable / Disable All Commands		<input checked="" type="checkbox"/>	
Run hello-world command with a project input.	xnat/hello-world:1.0	<input checked="" type="checkbox"/>	<button>Set Defaults</button>
Run ls command	hpc/wn-hpc2:cs7	<input checked="" type="checkbox"/>	<button>Set Defaults</button>



Logged in as: [formiso](#) | Auto-logout in: 0:14:46 - [renew](#) | [Logout](#)

[Browse](#) [New](#) [Upload](#) [Tools](#) [Help](#)

[Advanced](#)

Test-2

[Details](#) [Access](#) [Manage](#) [Pipelines](#)

ID: Test-2

Edit Details

Delete

Manage Custom Variables

Actions

- Add
- Add to Favorites
- Download XML
- Download Images
- Manage Files
- Upload Images
- View Prearchive
- Project Settings
- Scan Type Cleanup
- Run Containers
 - Hellow World: Project
 - ls

JSON Command Definition

```
1 {
2   "name": "",
3   "label": "",
4   "description": "",
5   "version": "",
6   "schema-version": "1.0",
7   "type": "docker",
8   "image": "",
9   "working-directory": "",
10  "command-line": "",
11  "override-entrypoint":[,
12  "mounts": [ ]
13  "environment-variables": { },
14  "ports": {},
15  ...
16  "inputs": [list of inputs that will be used
17             to resolve the command and launch the container ],
18
19  "outputs": [where container saves objects to be
20              upload to xnat],
21
22  "secrets": [providing credentials to containers
23              that need to connect to external services],
24
25  "xnat": [define how to pull files and properties
26           from XNAT objects into your containers,
27           and upload the containers' outputs back]
28 }
```

The screenshot displays the 'Plugin Settings' interface for XNAT. On the left, a sidebar lists navigation options: 'Container Service' (with sub-items 'Container Server Setup' and 'Images & Commands'), 'Command Configurations', 'Command Automation', 'Command History', 'OHIF Viewer', and 'OHIF Viewer Settings'. The main area is titled 'Installed Container Images and Commands' and shows two installed images:

- hpc/wn-hpc2:cs7**: Includes an 'Add New Command' button and a table with one command: 'ls'. The table columns are 'Command', 'XNAT Actions' (containing '• xnat:projectData: Run ls command'), 'Site-wide Config' (N/A), 'Version', and 'Actions' (edit and delete icons).
- xnat/hello-world:1.0**: Includes an 'Add New Command' button and a table with one command: 'hello-world'. The table columns are 'Command', 'XNAT Actions' (containing '• xnat:projectData: Run hello-world command with a project input.'), 'Site-wide Config' (N/A), 'Version', and 'Actions' (edit and delete icons).

An 'Edit Definition For ls' dialog box is open in the foreground, showing the JSON definition for the 'ls' command. The 'inputs' field is highlighted with a red box. The dialog also shows 'Command Info URL: n/a' and a 'View stdout' panel on the right displaying a list of system files and directories.

```
1- [
2  "name": "ls",
3  "description": "A linux basic command",
4  "image": "hpc/wn-hpc2:cs7",
5  "type": "docker",
6  "command-line": "ls",
7  "mounts": [],
8  "environment-variables": {},
9  "ports": {},
10 "inputs": [],
11 "outputs": [],
12 "xnat": [
13   {
14     "name": "project",
15     "label": "ls",
16     "description": "Run ls command",
17     "contexts": [
18       "xnat:projectData"
19     ],
20     "external-inputs": [
21       {
22         "name": "project",
23         "description": "this input accepts a project",
24         "type": "Project",
25         "matcher": null,
26         "default-value": null,
27         "required": true,
28         "replacement-key": null,
29         "sensitive": null,
30         "provides-value-for-command-input": null,
31         "provides-files-for-command-mount": null,
32         "via-setup-command": null,
33         "user-settable": null,
34         "load-children": true

```

Changes are not submitted automatically.
The containing form will need to be submitted to save.

Cancel Save

Riflessioni finali

- XNAT as is
 - Gestione ruoli per progetto
 - Disponibilità plugin e API
 - Maturità del software (20 anni di sviluppo)
 - Favorisce la condivisione dati e la cooperazione tra gruppi di ricerca fra enti diversi
 - Completo ma complesso

- XNAT nice to have
 - Sviluppo plugin interfaccia batch job indipendente dallo scheduler
 - Condivisione workflow/immagini docker/comandi tra i gruppi di fisica medica interni all'ente e/o fra enti diversi
 - Container Service on Kubernetes (an example of setting up a non-production cluster using minikube)

```
{  
  "Messaggio": "Grazie a tutti per l'attenzione",  
  "Domande ?": [  
    "..."  
  ]  
}
```