XNAT WORKSHOP 2022

Welcome to XNAT Workshop 2022

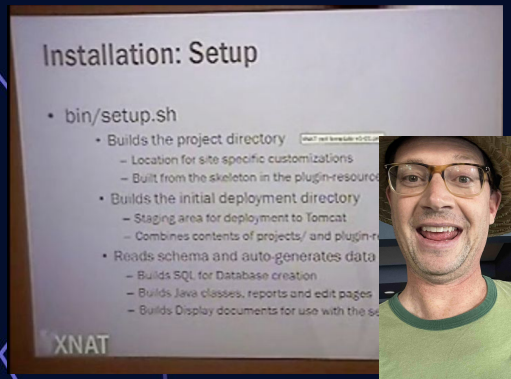
Dan Marcus
Chief Scientific Officer, Flywheel
Professor of Radiology, Washington University

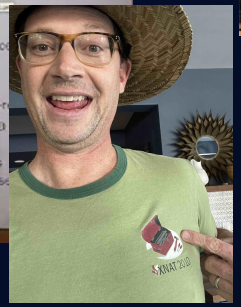
UCL ICR The Institute of Cancer Research NCITA National Cancer Imaging Translational Accelerator SyneRBI Health+Bioscience IDEAS Flywheel

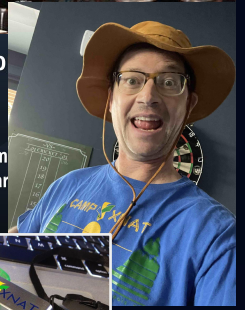
Presenter: Dan Marcus, Flywheel & WashU

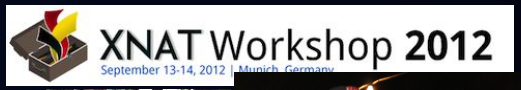
- Chief Scientific Officer (not meant to be ironic) @ Flywheel
- Professor of Radiology & Director of the Computational Imaging Research Center @ WashU
- Worked on XNAT since before it was XNAT
- Haven't been back to England since 2017 sabbatical. I will be needing some Nando's .

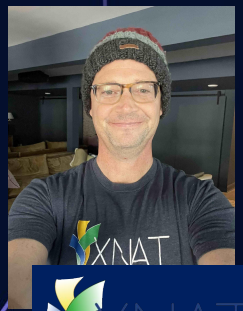
Workshops are an important part of the XNAT experience – thanks for coming

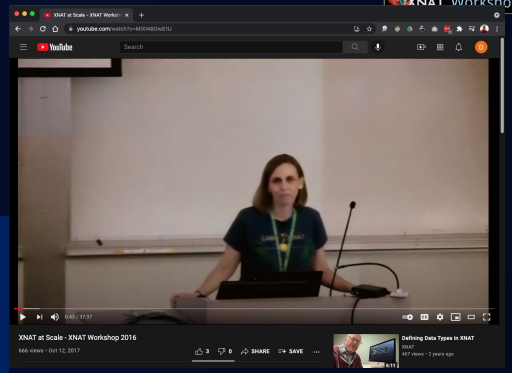






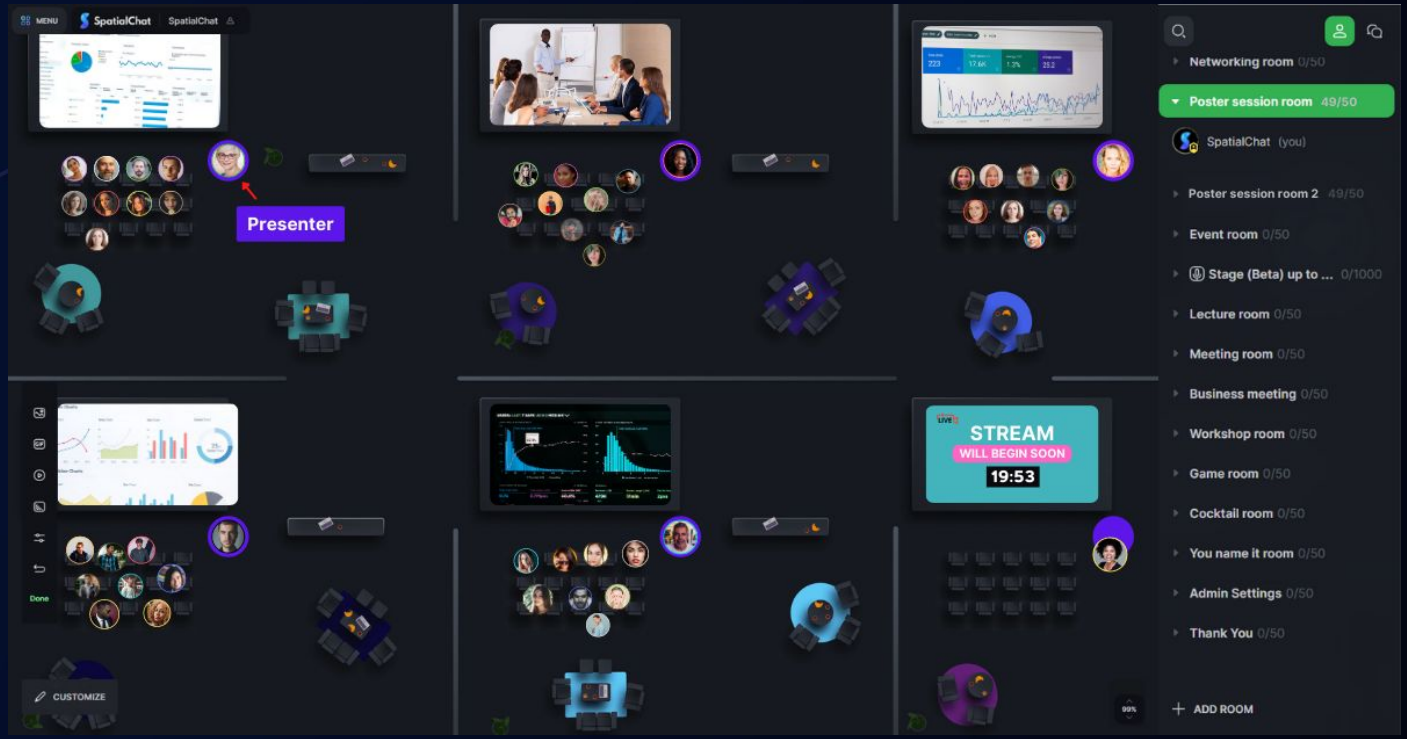






UCL ICR The Institute of Cancer Research

Workshops are an important part of the XNAT experience – thanks for coming

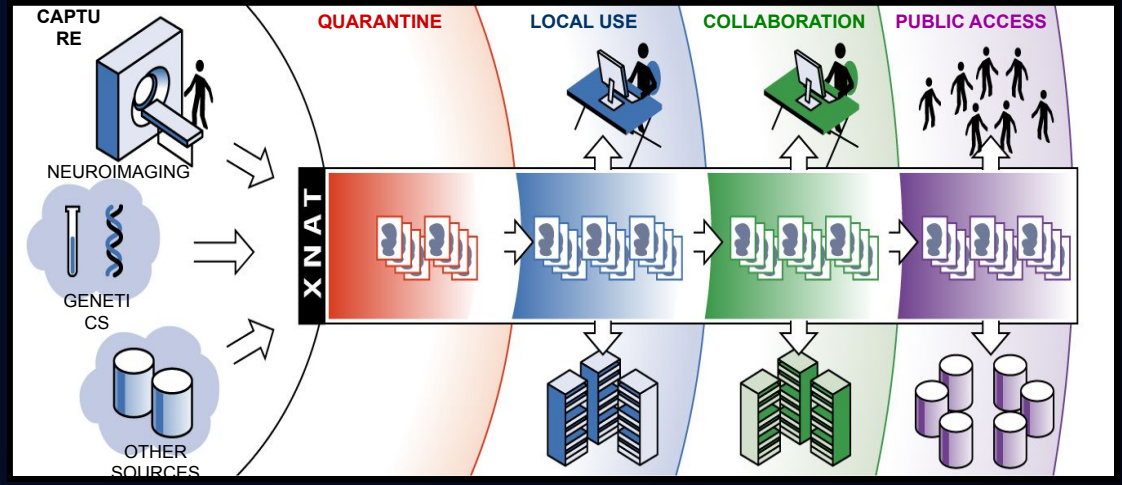


Today's Themes

- Continuity
- Evolution
- Sustainment

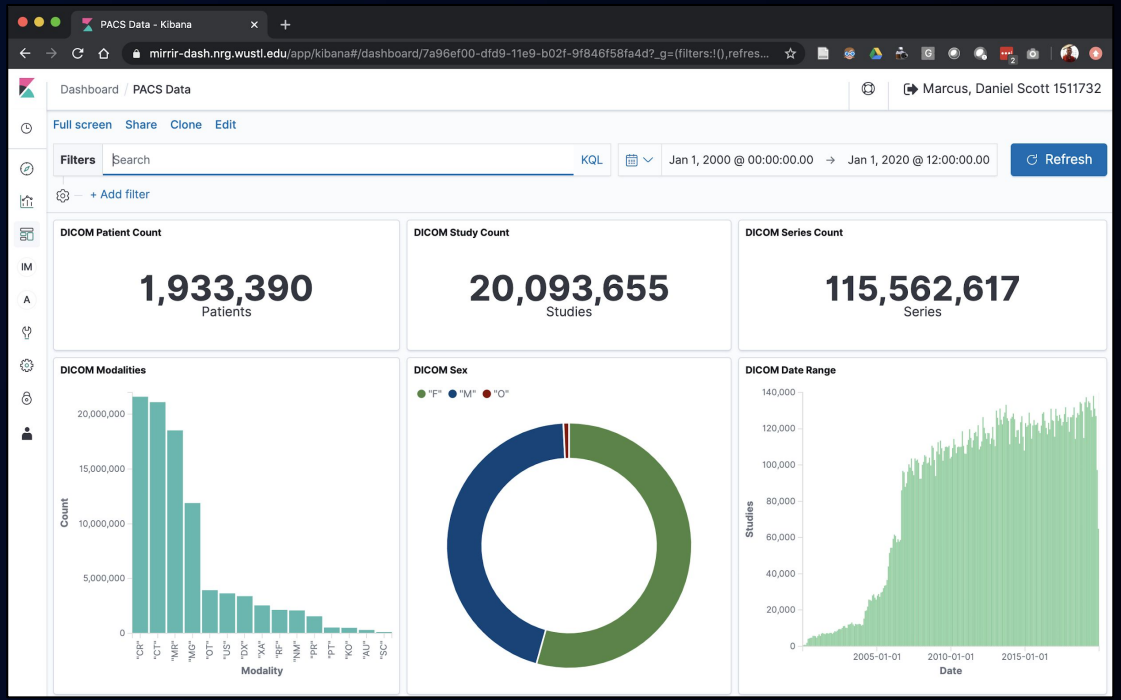
Today's Themes

- Continuity
- Evolution
- Sustainment



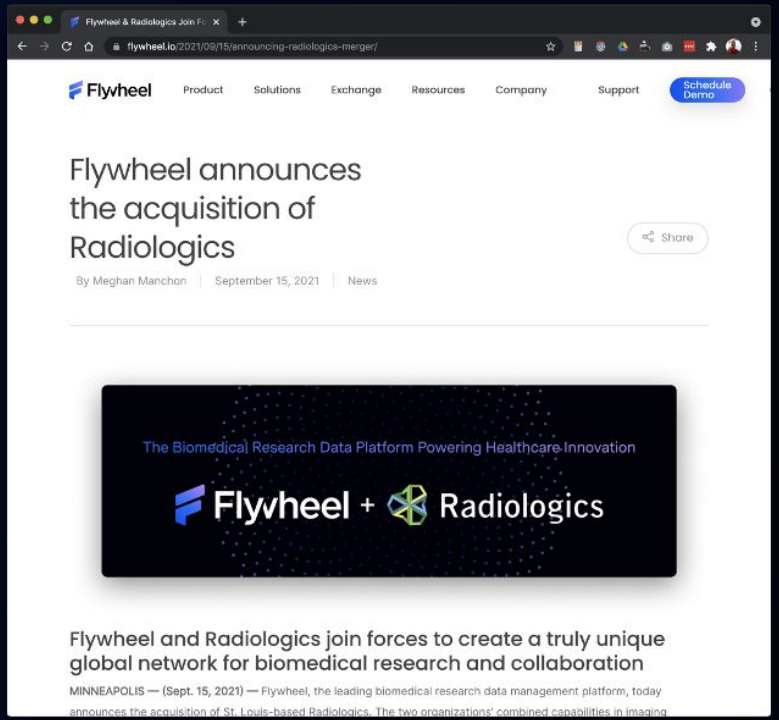
Today's Themes

- Continuity
- Evolution
- Sustainment



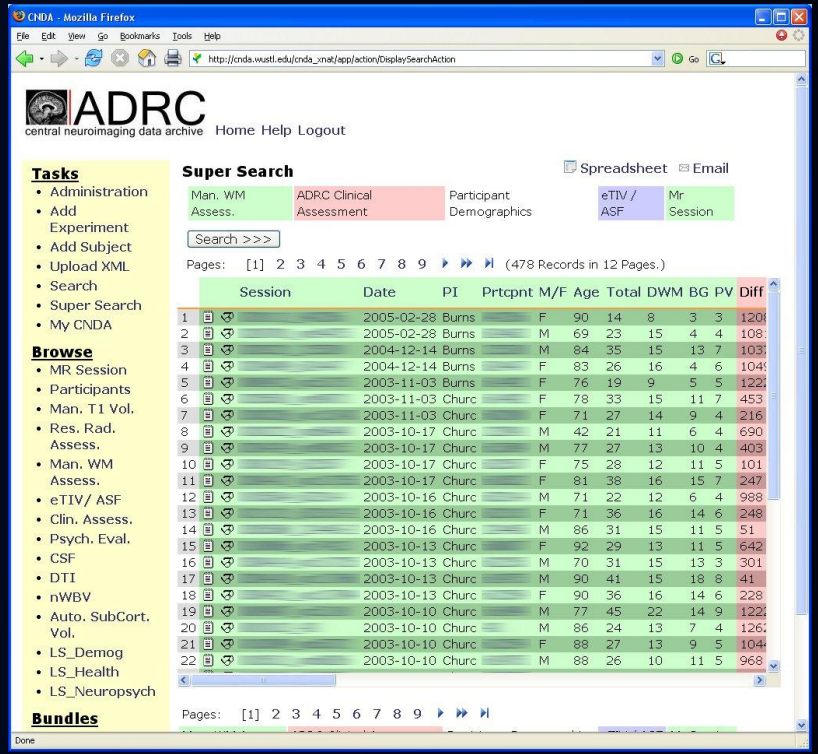
Today's Themes

- Continuity
- Evolution
- Sustainment



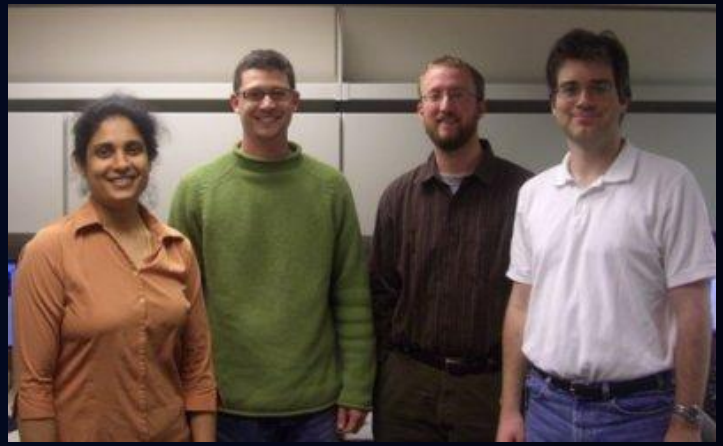
The origin story: Birth

- It all begin ~2001 at the WUMC Alzheimer's Disease Research Center
- CDs were awkward, QC was sporadic, and processing was inconsistent.
- DICOM was barely a thing.
- Randy Buckner asked me to write some scripts to better manage the data

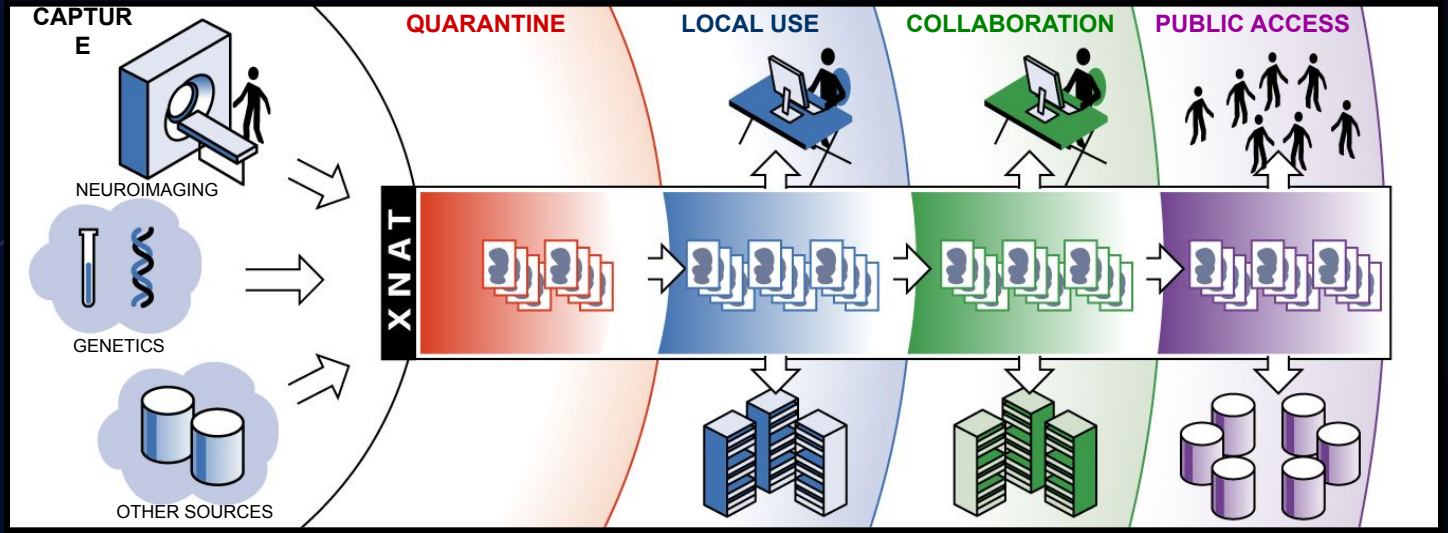


The origin story: Infancy

- Instead, I wrote a web app. Randy liked it. We called it the CNDA.
- He committed HHMI resources to build it.
- Tim Olsen & Mohana Ramaratnam hired as the first XNAT developers. Kevin Archie joined soon after in 2002
- First open source release followed soon after.



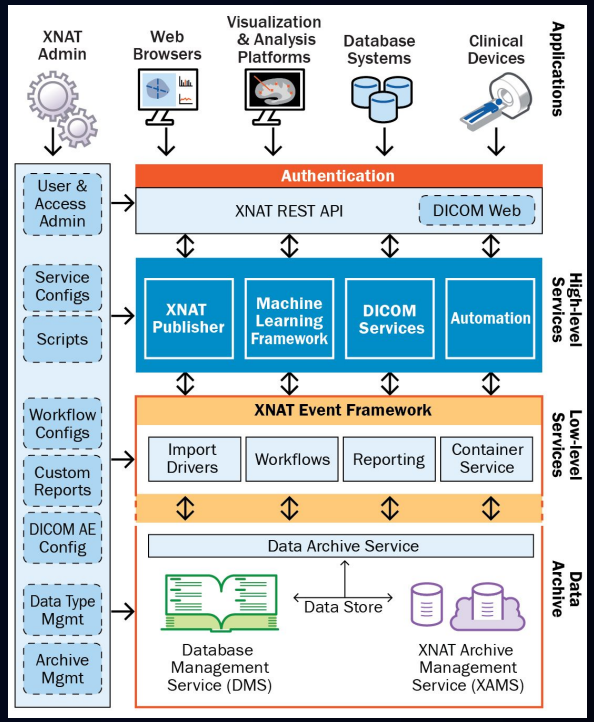
The origin story: Adolescence



- We joined the Biomedical Informatics Research Network (BIRN) in 2005
  - Freesurfer, 3D Slicer, ADNI, Human Connectome Project, XNAT, BIDS, Pipelines
- First XNAT R01 grant started in 2008 (24 letters)

The origin story: Coming of Age

- Growth of the XNAT team (40+ developers over the years)
- Expansion beyond neuroimaging
- Radiologics founded (2009)
- Human Connectome Project (2009)
- XNAT R01 renewal (2012: 53 letters)

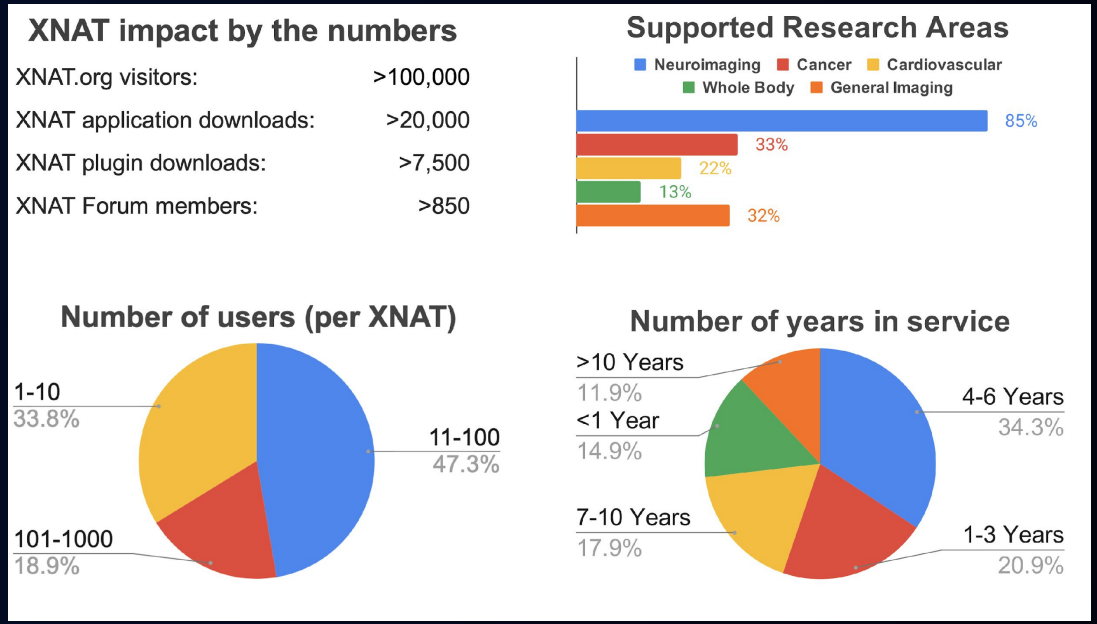


The origin story: Adulthood

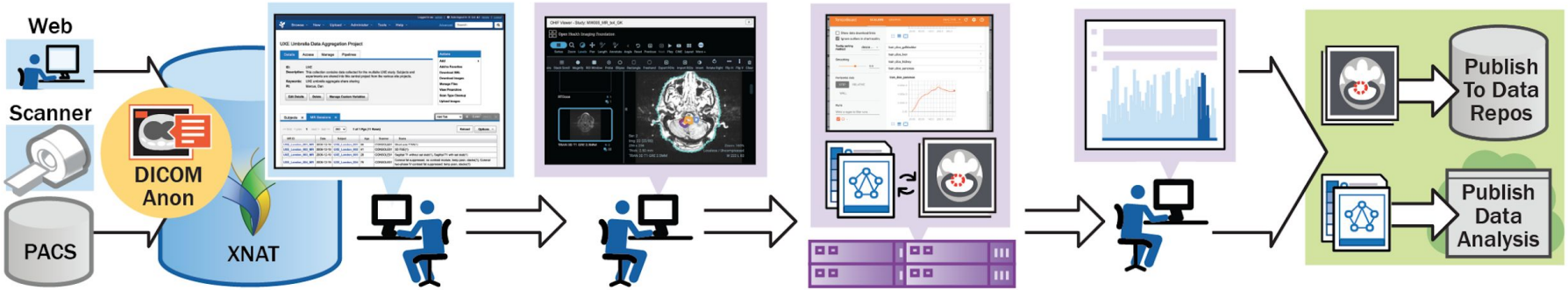
- Global adoption across many biomedical domains
- Links with many industry and academic initiatives
- Containerization introduced
- AI drives many use cases
- XNAT grant renewal (2016: 107 letters)

XNAT Today

- Broad DICOM support
- Modern open image viewer
- Containerized processing
- Comprehensive API
- Extensive administration interface
- Automations
- Integrated notebooks

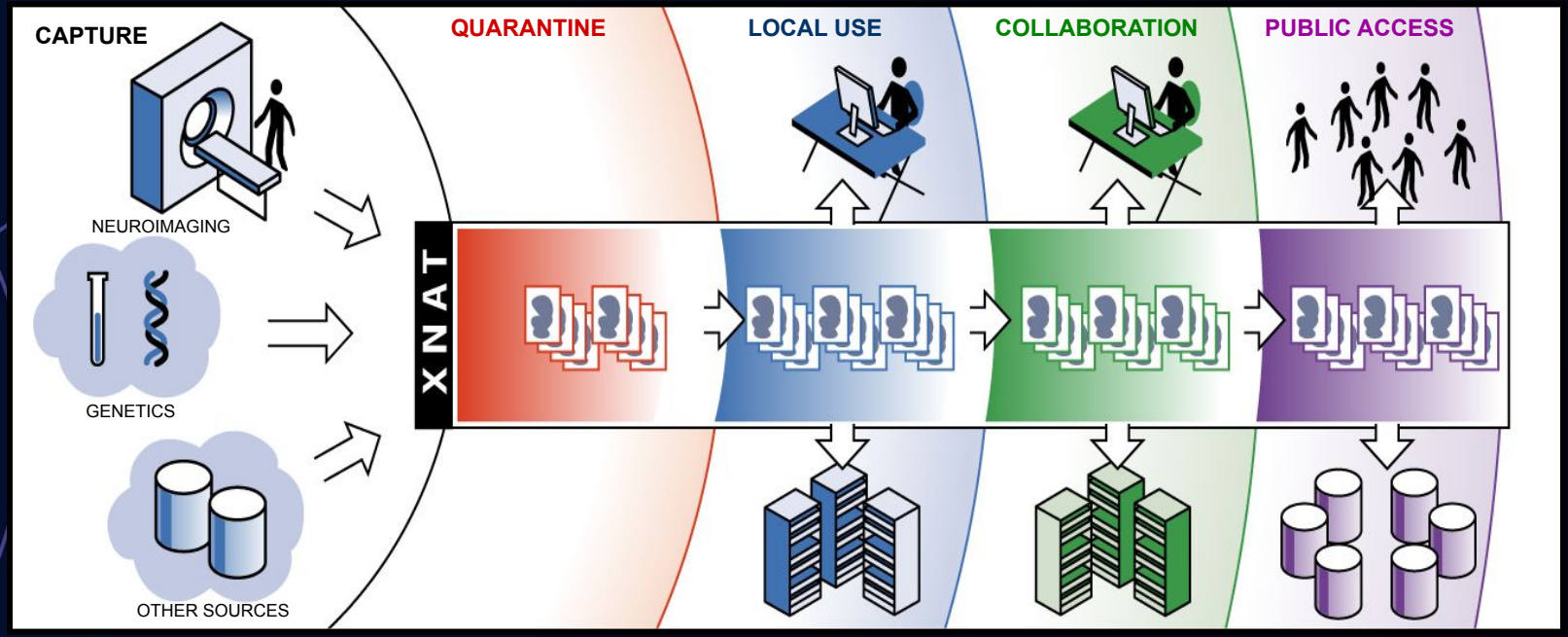


XNAT Today



INGEST	CURATE	ANNOTATE	COMPUTE	ANALYZE	PUBLISH
• DICOM send from scanner • DICOM retrieve from PACS • Web-based upload • Metadata anonymization • Pixel anonymization • Face scrubbing • Support for all imaging modalities. • Support for all file formats (DICOM, NIFTI, TIFF, etc.)	• Automated image quality metrics • Manual image review • Pre-archive data staging area • Scan type harmonization • Group-level image statistics • Linked clinical, genetic, and other non-imaging data • Automated format conversion	• OHIF integration • Manual annotation tools (ROI, angles, lines, etc.) • AI-assisted annotation • Templatized assessment forms • Rapid reader module • Blinded reader mode • Radreport.org integration	• Docker Container Service • HPC integration (Slurm, Torque, PBS, etc.) • Batch processing dashboard • Live Tensorboard and stdout/stderr monitoring • Event-based container automation	• Standalone Jupyter integration • CLARA-based ML development • Scriptable data sets for training, test, validation • Scriptable analysis with Python and Groovy • Integrations with common analysis tools (3D Slicer, MITK, CapTk, etc.)	• Data sharing across projects • Data sharing across instances • Federated datasets across instances • Automated export to public data repositories (TCIA, Openneuro, etc.) • Automated export to public analysis platform (Imaging Data Commons, Brainlife.io, etc.)

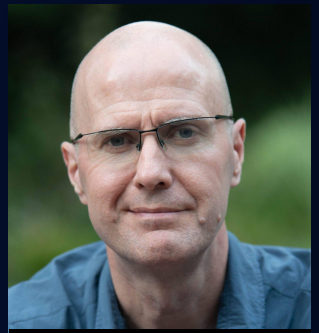
XNAT Today


CAPTURE
NEUROIMAGING
GENETICS
OTHER SOURCES
XNAT
QUARANTINE
LOCAL USE
COLLABORATION
PUBLIC ACCESS

XNAT Today

Kate Alpert
Sr Director of Engineering

Tim Olsen
Sr VP of Clinical Engineering



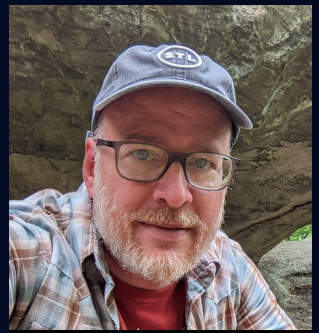
James Dickson
Senior Director, Customer Solutions and Support

Dan Marcus
Chief Scientific Officer, Professor of Radiology

Andy Lassiter
Programmer

John Flavin
Backend Team Lead

Rick Herrick
Sr Software Engineer



Will Horton
Sr Product Owner

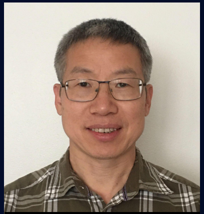
Matt Kelsey
Programmer

UCL ICR The Institute of Cancer Research NCITA National Cancer Imaging Translational Accelerator lywheel

XNAT Today


Dana Gleason
Technical Project Manager


Dakota Castleberg
Lead Frontend Engineer


Bin Zhang
Software Engineer


Rose Lutz
QA Analyst


Aaron Mintz
Medical Director


Michael Hileman
Solutions Engineer


Angela Farrar
Sr Director of Regulatory Affairs


Roger Chylla
Senior Director, Clinical Solutions


James Ransford
Senior Software Engineer


Ian Gauthier
Software Engineer


Tyler Ratliff
Clinical Quality Assurance Lead


Kevin Archie
Sr Software Engineer


Brian Holt
Director of Clinical Infrastructure & IT


Sean Petrick
System Administrator


Remya Nair
Senior Solutions Engineer


Blake Griggs
Senior Account Manager


Charlie Moore
Sr. Software QA Engineer


Mohana Ramaratnam
Sr, Programmer Analyst


MD S Hussain
Quality Assurance Analyst

UCL · ICR The Institute of Cancer Research · NCITA National Cancer Imaging Translational Accelerator · SyneRBI · Health+Bioscience IDEAS · Flywheel

XNAT Today

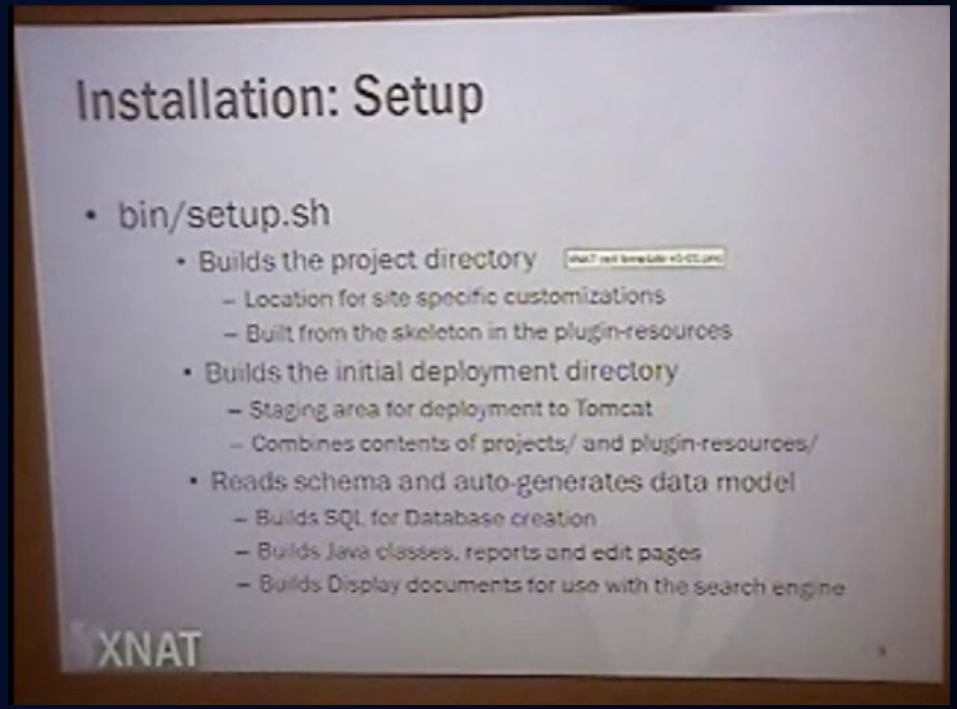
Gunnar Schaefer
Chief Technology Officer & Founder

Justin Ehlert
Senior Director of Engineering

Amina Chebira
Director of Relationship Management

Quinn Proffer
VP of Customer Operations

Evolution: Installation



Evolution: Installation

Installing

Start by cloning the xnat-docker-compose repository and checking out the `features/dependency-mgmt` branch:

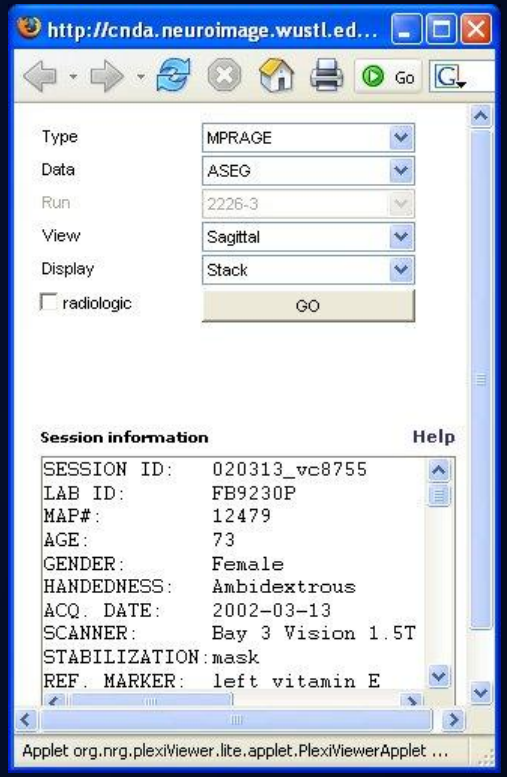
```
$ git clone https://github.com/NrgXnat/xnat-docker-compose
$ cd xnat-docker-compose
$ git checkout features/dependency-mgmt
```

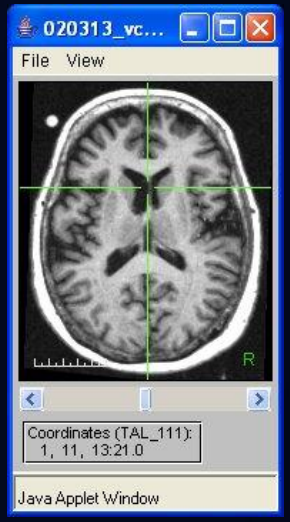
Launching

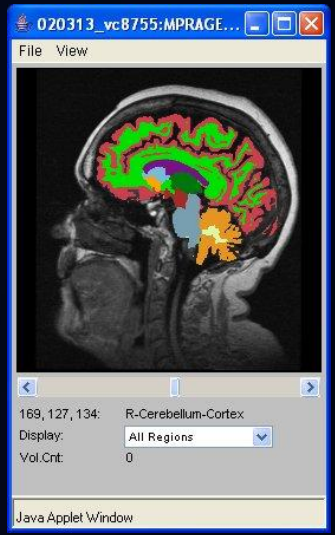
At this point, you can start XNAT with a basic configuration just by building and launching the `docker-compose` configuration:

```
$ ./gradlew composeBuild composeUp
```

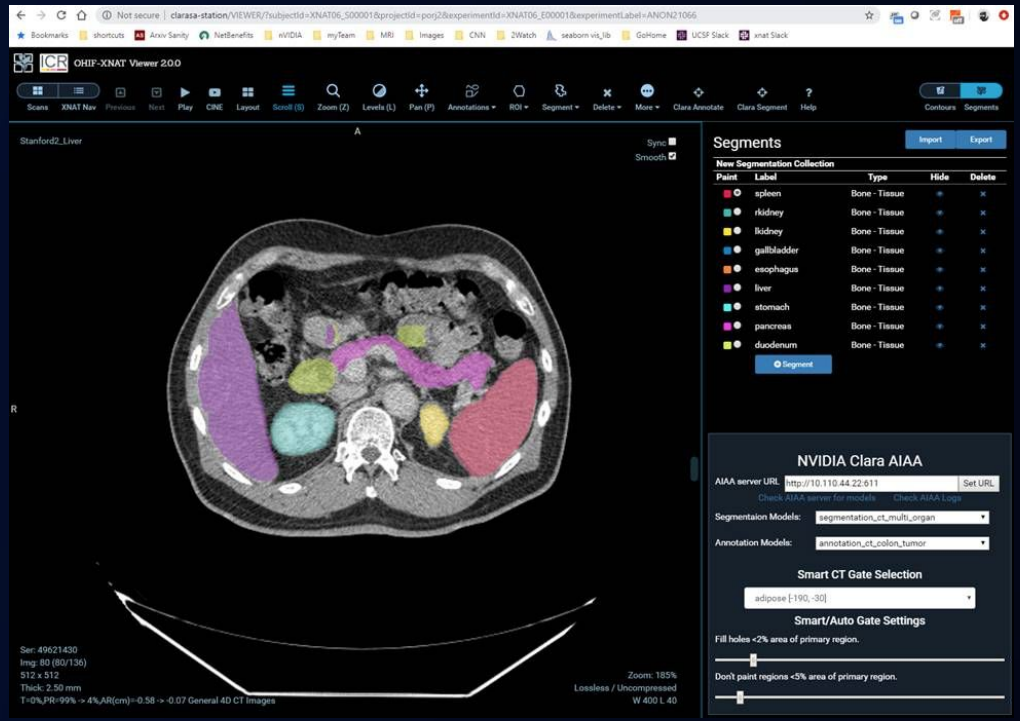
Evolution: Viewer







Evolution: Viewer



Evolution: Interfaces

Why REST?

- History
  - SOAP, ArcGet, ArcPut, StoreXAR, StoreXML
  - Cumbersome, Difficult in some languages
- URIs uniquely identify resources (meta & file)
- Uses basic HTTP model
- REST, REST-ful, REST-like
  - HTTP Sessioning

XNAT

5

Evolution: Interfaces

XNAT REST API

The XNAT REST API (XAPI) functions provide access to XNAT internal functions for remote clients.

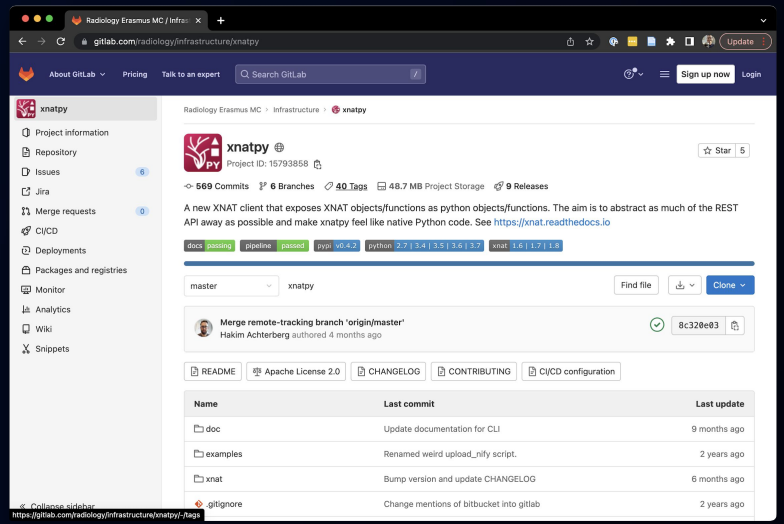
Created by XNAT
See more at http://www.xnat.org
Contact the developer
Simplified 2-Clause BSD

anonymize-api : XNAT DICOM Anonymization API — Show/Hide | List Operations | Expand Operations

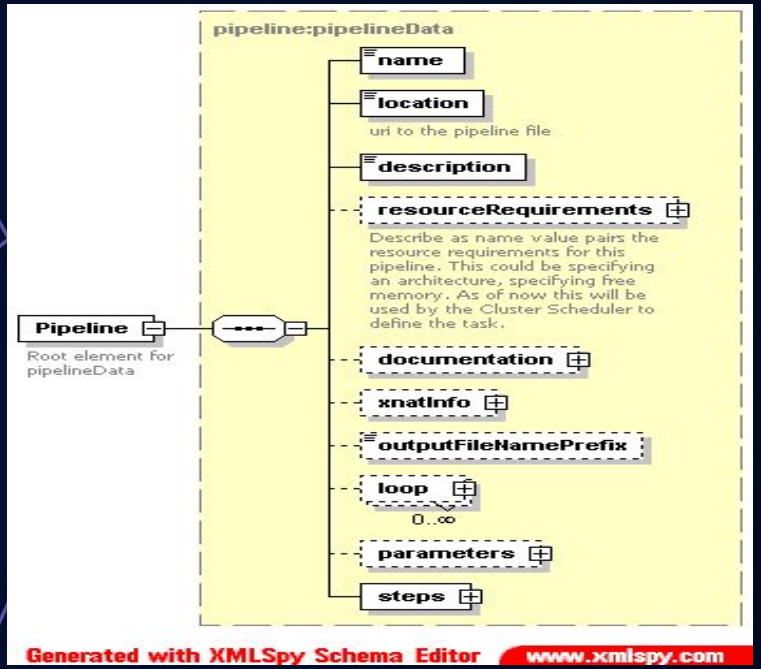
GET	/xapi/anonymize/default	Gets the default anonymization script.
GET	/xapi/anonymize/projects/{projectId}	Gets the project-specific anonymization script.
PUT	/xapi/anonymize/projects/{projectId}	Sets the project-specific anonymization script.
GET	/xapi/anonymize/projects/{projectId}/enabled	Indicates whether the project-specific anonymization script is enabled or disabled.
PUT	/xapi/anonymize/projects/{projectId}/enabled	Enables or disables the project-specific anonymization script.
GET	/xapi/anonymize/site	Gets the site-wide anonymization script.
PUT	/xapi/anonymize/site	Sets the site-wide anonymization script.
GET	/xapi/anonymize/site/enabled	Indicates whether the site-wide anonymization script is enabled or disabled.
PUT	/xapi/anonymize/site/enabled	Enables or disables the site-wide anonymization script.

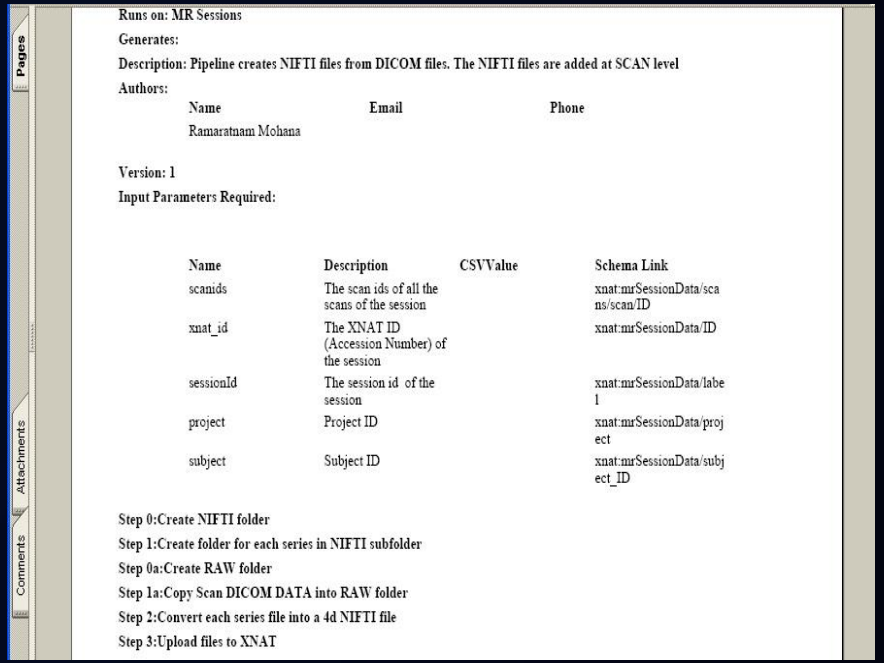
automation-api : Automation Service API — Show/Hide | List Operations | Expand Operations

catalog-api : XNAT Archive and Resource Management API — Show/Hide | List Operations | Expand Operations



Evolution: Compute





Runs on: MR Sessions

Generates:

Description: Pipeline creates NIFTI files from DICOM files. The NIFTI files are added at SCAN level

Authors:

Name	Email	Phone
Ramaratnam Mohana		

Version: 1

Input Parameters Required:

Name	Description	CSVValue	Schema Link
scanids	The scan ids of all the scans of the session		xnat:mrSessionData/scans/scan/ID
xnat_id	The XNAT ID (Accession Number) of the session		xnat:mrSessionData/ID
sessionId	The session id of the session		xnat:mrSessionData/label
project	Project ID		xnat:mrSessionData/project
subject	Subject ID		xnat:mrSessionData/subject_ID

Step 0:Create NIFTI folder

Step 1:Create folder for each series in NIFTI subfolder

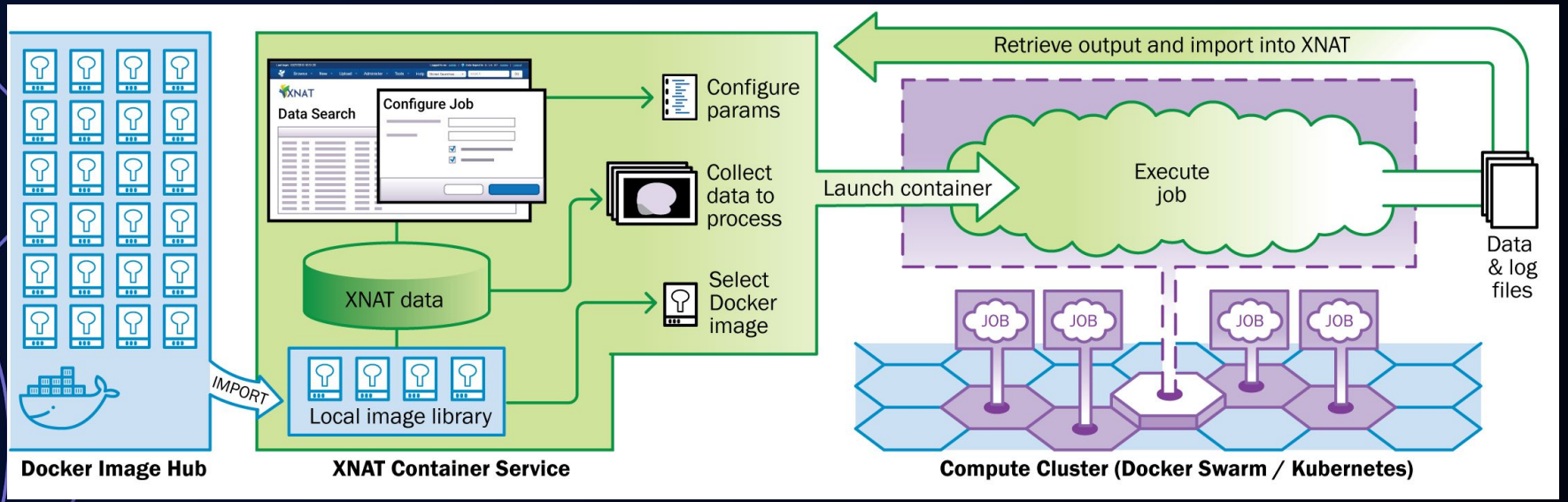
Step 0a:Create RAW folder

Step 1a:Copy Scan DICOM DATA into RAW folder

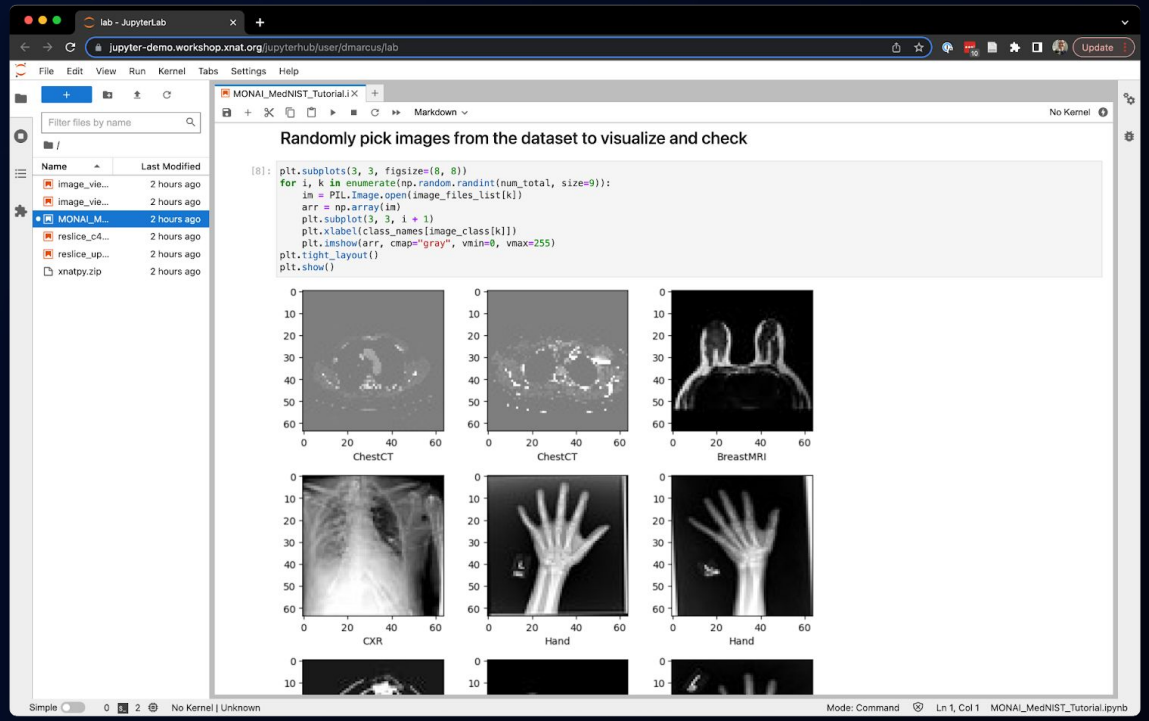
Step 2:Convert each series file into a 4d NIFTI file

Step 3:Upload files to XNAT

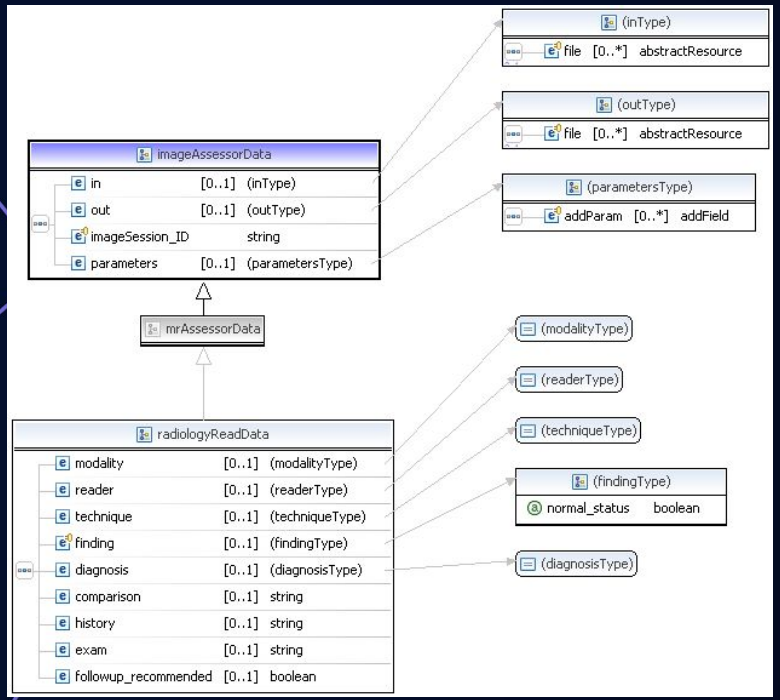
Evolution: Compute



Evolution: Compute

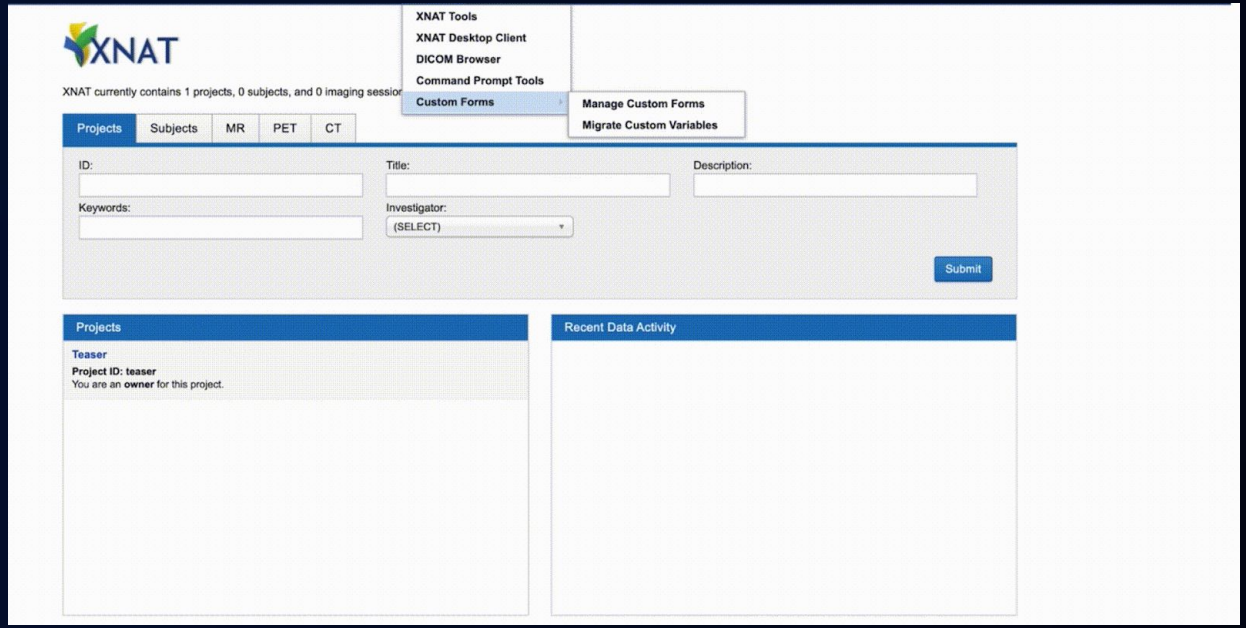


Evolution: Customization

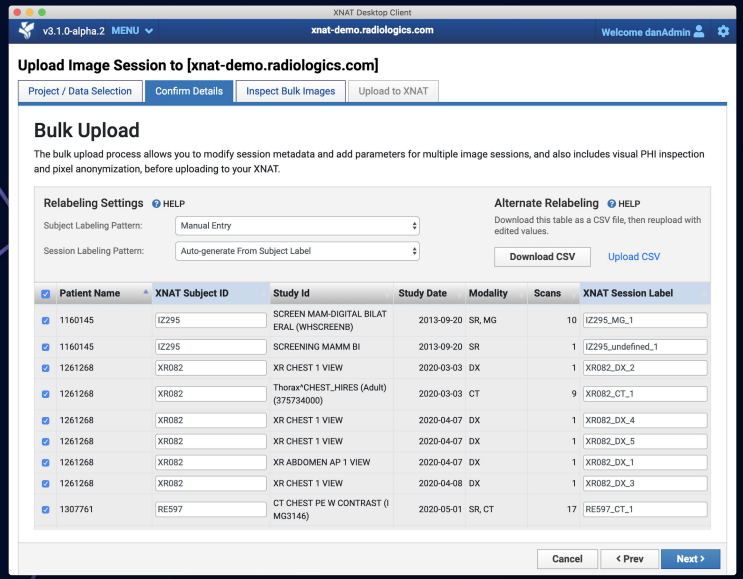


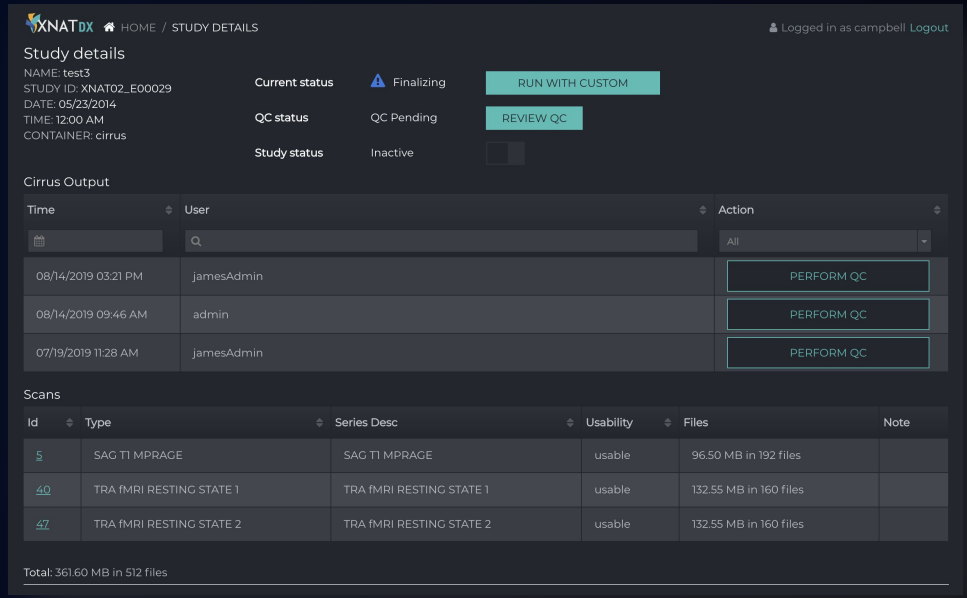

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSPY v2004 rel. 3 U (http://www.xmlspy.com) by Tim Olsen (Washington University) -->
<Displays xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="../../xdat/display.xsd" schema-element="xnat:mrSessionData" full-description="MR Session"
brief-description="MR Session">
    <Arc-Definition id="ASSESSOR">
        <CommonField id="EXPT_ID" type="STRING"/>
        <CommonField id="ASSESSED_EXPT_ID" type="STRING"/>
        <Bridge-Element name="xnat:mrSessionData" field="SESSION_ID"/>
        <Filter field="EXPT_ID" filterType="distinct"/>
        <Filter field="ASSESSED_EXPT_ID" filterType="equals"/>
    </Arc-Definition>
    <Arc name="PARTICIPANT_EXPERIMENT">
        <CommonField id="PART_ID" local-field="SUBJECT_ID"/>
        <CommonField id="DATE" local-field="DATE"/>
        <CommonField id="EXPT_ID" local-field="SESSION_ID"/>
    </Arc>
    <DisplayField id="DATE" header="Date" visible="true" searchable="true" data-type="date" sort-order="DESC">
        <DisplayFieldElement name="Field1" schema-element="xnat:mrSessionData.date"/>
        <description>MR Session Date (DATE)</description>
    </DisplayField>
    <DisplayField id="DATE_CHAR" header="Date" visible="true" sort-by="DATE" sort-order="DESC">
        <DisplayFieldElement name="Field1" schema-element="xnat:mrSessionData.date"/>
        <Content type="sql">CAST(@Field1 AS VARCHAR)</Content>
        <description>MR Session Date (String)</description>
    </DisplayField>
    <DisplayVersion versionName="listing" default-order-by="DATE" dark-color="DEDEDE" light-color="FFFFFF" default-sort-order="DESC">
        <DisplayFieldRef id="LABEL"/>
        <DisplayFieldRef id="DATE"/>
        <DisplayFieldRef id="PROJECT"/>
        <DisplayFieldRef id="SUBJECT_LABEL" element_name="xnat:subjectData"/>
        <DisplayFieldRef id="GENDER_TEXT" element_name="xnat:subjectData"/>
        <DisplayFieldRef id="AGE"/>
    </DisplayVersion>
    <ViewLink alias="ORDERED_WORKFLOWS">
        <Mapping TableName="ORDERED_WORKFLOWS">
            <MappingColumn rootElement="xnat:mrSessionData" fieldElement="xnat:mrSessionData.ID" mapsTo="id"/>
        </Mapping>
    </ViewLink>
    <SQLView name="ordered_workflows" sql="SELECT wrk_workflowdata.id, status, wrk_workflowdata_id,
     CASE pipeline_name
        WHEN 'Transfer'::text THEN 'Archive'::text
        ELSE
          CASE xs_lastposition('/'::text, pipeline_name::text) WHEN 0 THEN pipeline_name ELSE
          substring(substring(pipeline_name::text, xs_lastposition('/'::text, pipeline_name::text) + 1), 1, xs_lastposition('.'::text, substring(pipeline_name::text, xs_lastposition('/'::text, pipeline_name::text) +
1)) - 1)
      END END AS pipeline_name
   FROM wrk_workflowdata
   RIGHT JOIN ( SELECT wrk_workflowdata.id, max(wrk_workflowdata.launch_time) AS launch_time
          FROM wrk_workflowdata
         GROUP BY wrk_workflowdata.id) wrk_max ON wrk_workflowdata.id::text = wrk_max.id::text AND wrk_workflowdata.launch_time = wrk_max.launch_time"/>
</Displays>
```

Evolution: Customization



Evolution: Customization





A bit about Flywheel

2011 Dr. Brian Wandell and Gunnar Schaefer work together at Stanford University's Center for Cognitive and Neurobiological Imaging to develop a medical imaging data management and collaboration platform.

2015 Wandell and Schaefer partner with Minnesota-based Invenshure to launch Flywheel.

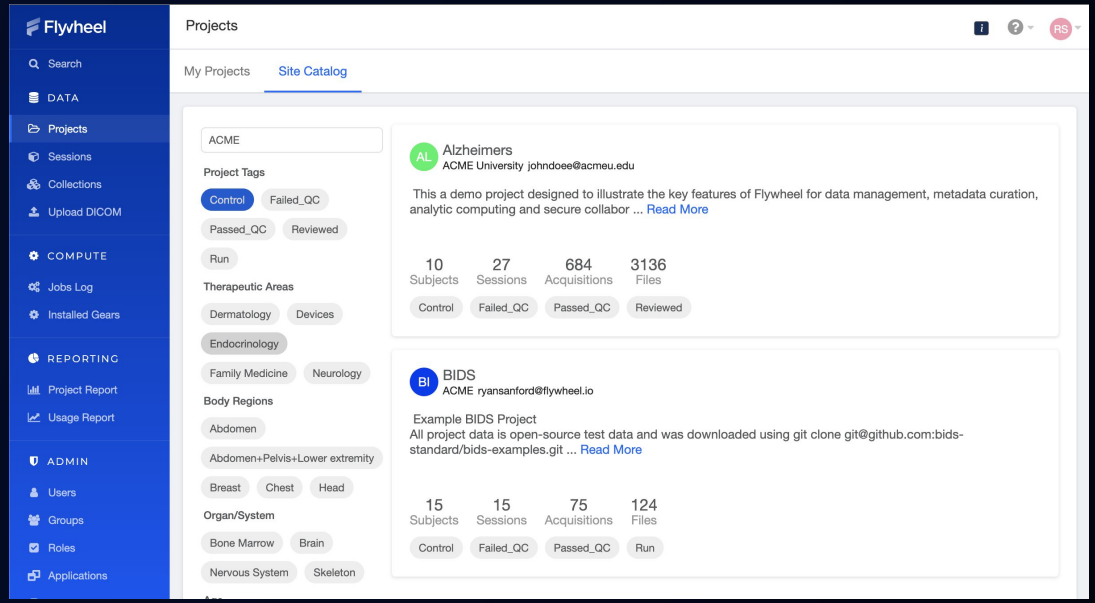
2018 With a focus on the academic research community, Flywheel grows quickly, helping researchers focus on research and not IT.

2019 Flywheel lands its first commercial customer, Roche and Genentech, providing a global platform to enable the ingestion and automated curation of massive amounts of data for their digital transformation initiative.

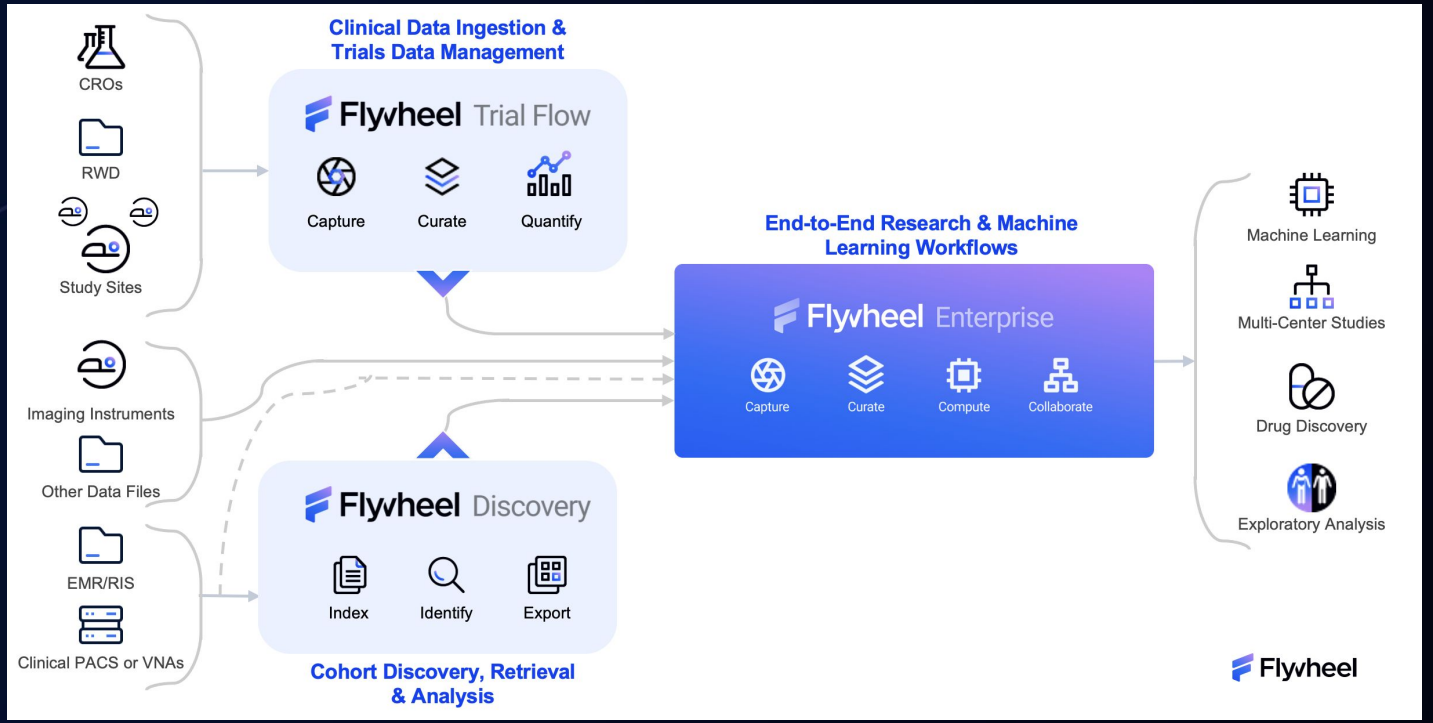
2021 Flywheel adds to its expertise and talent base with the acquisition of Radiologics creating the only global network for biomedical research and collaboration.

A bit about Flywheel

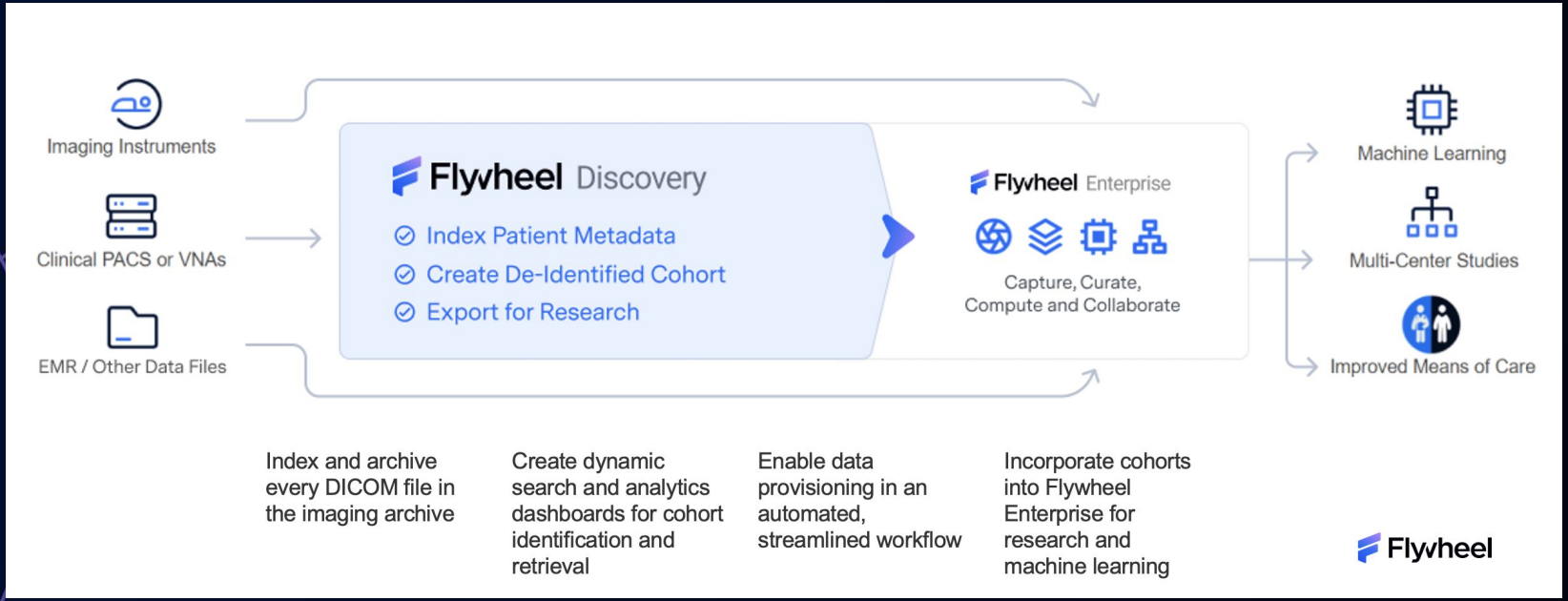
- Project-based data management
- OHIF Viewer
- Containerized apps (Gears)
- DICOM de-ID
- Provenance & audit trails
- Roles & managed access



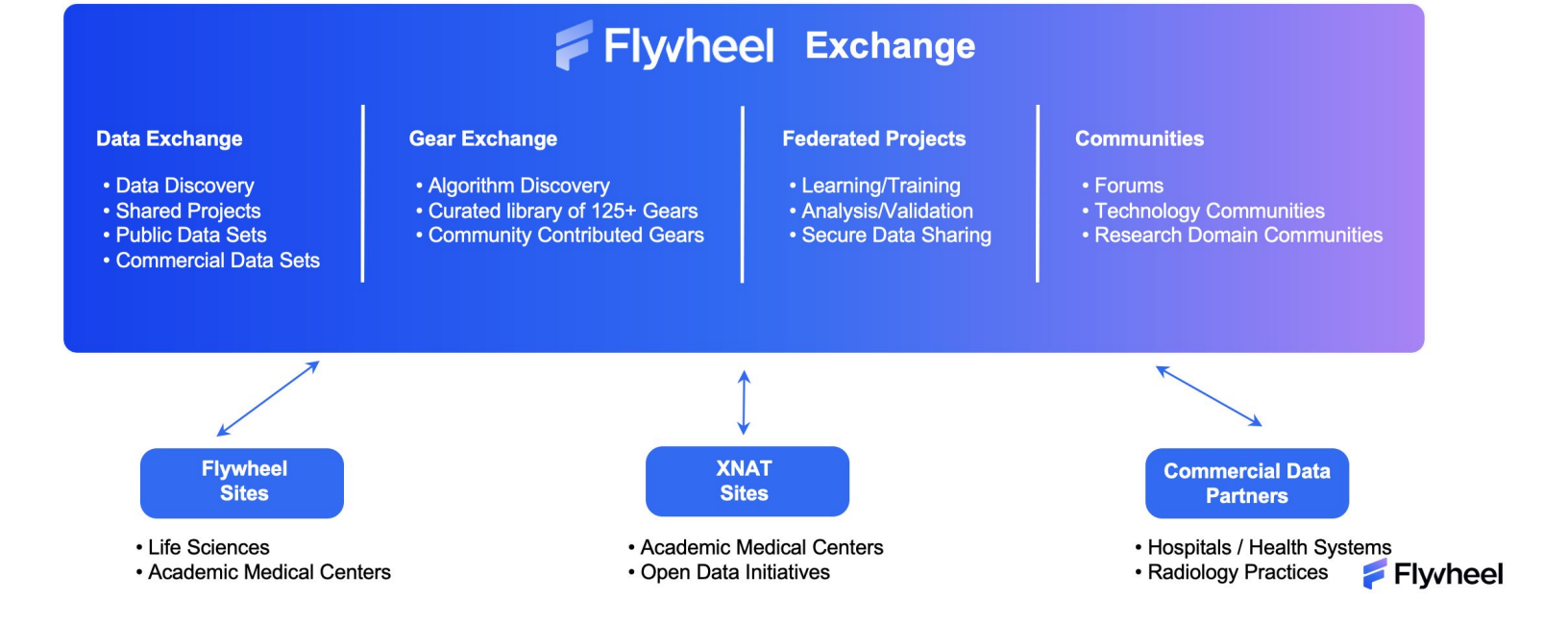
A bit about Flywheel



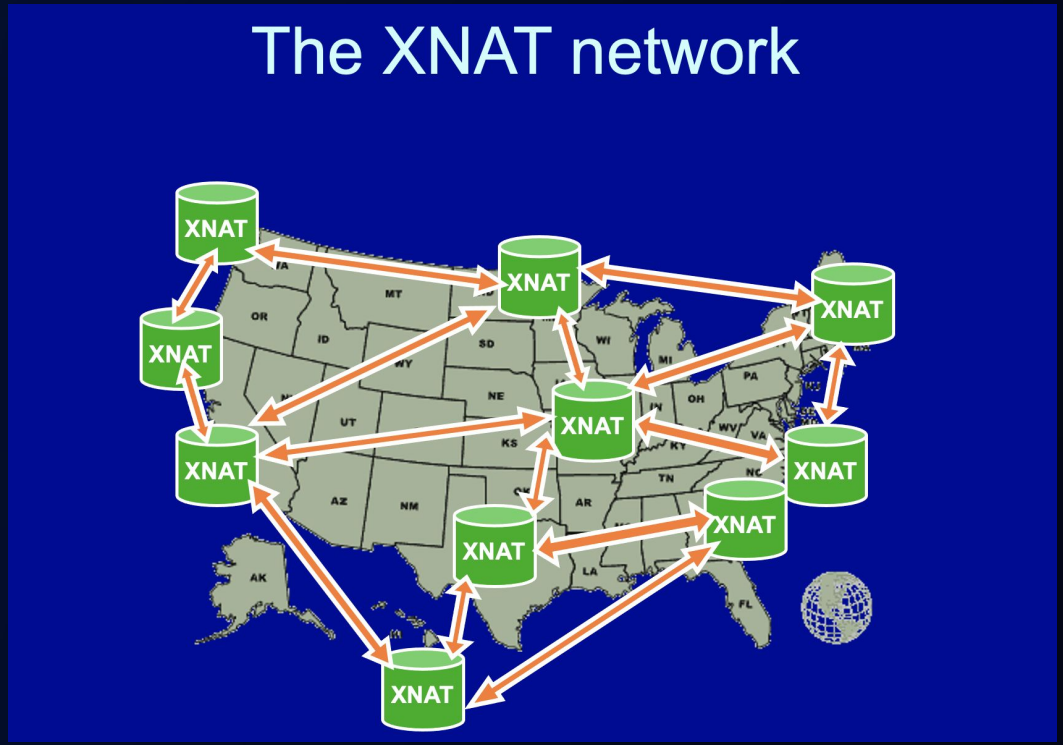
A bit about Flywheel



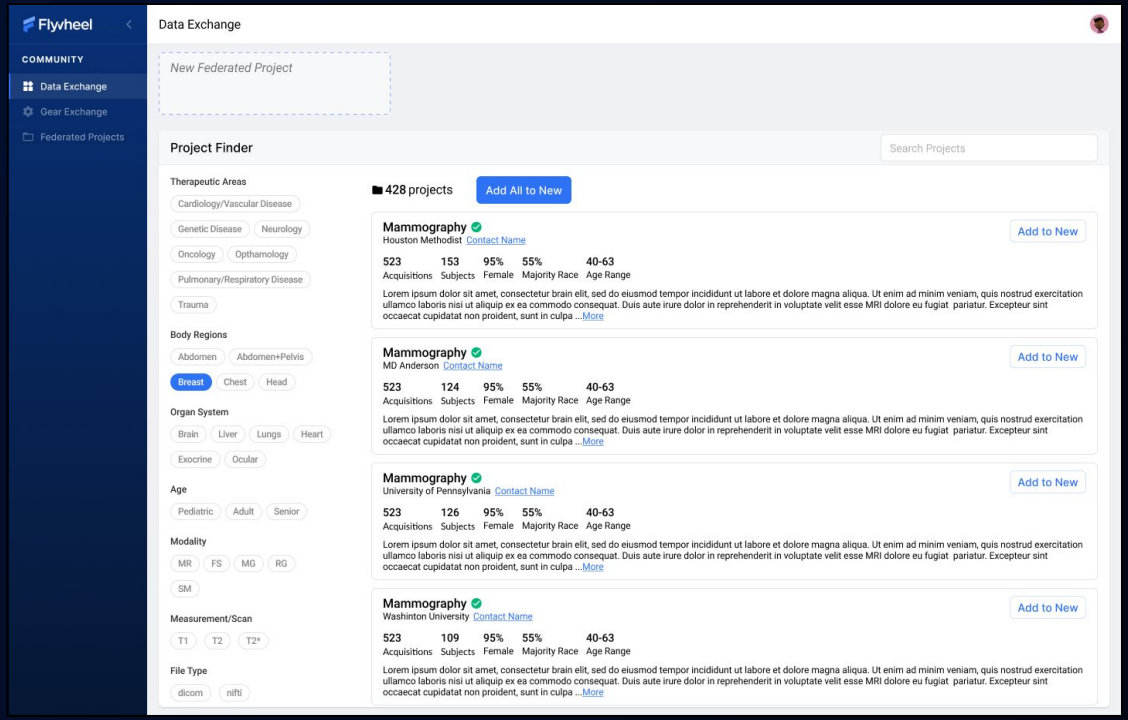
A bit about Flywheel



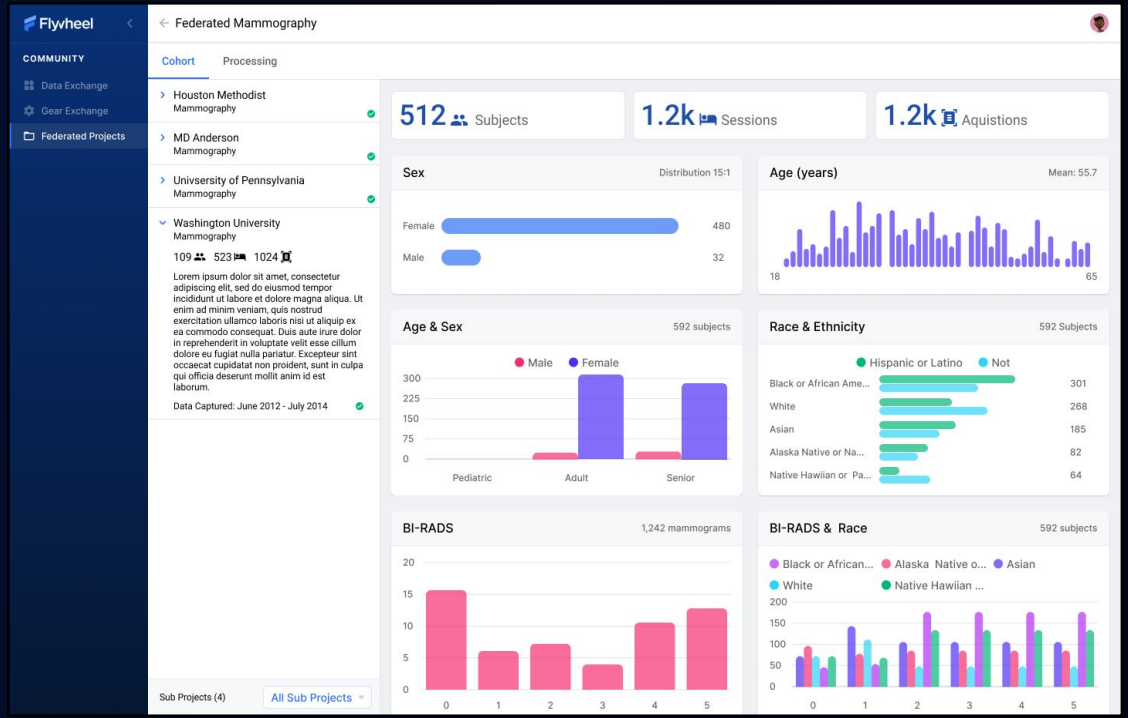
A bit about Flywheel



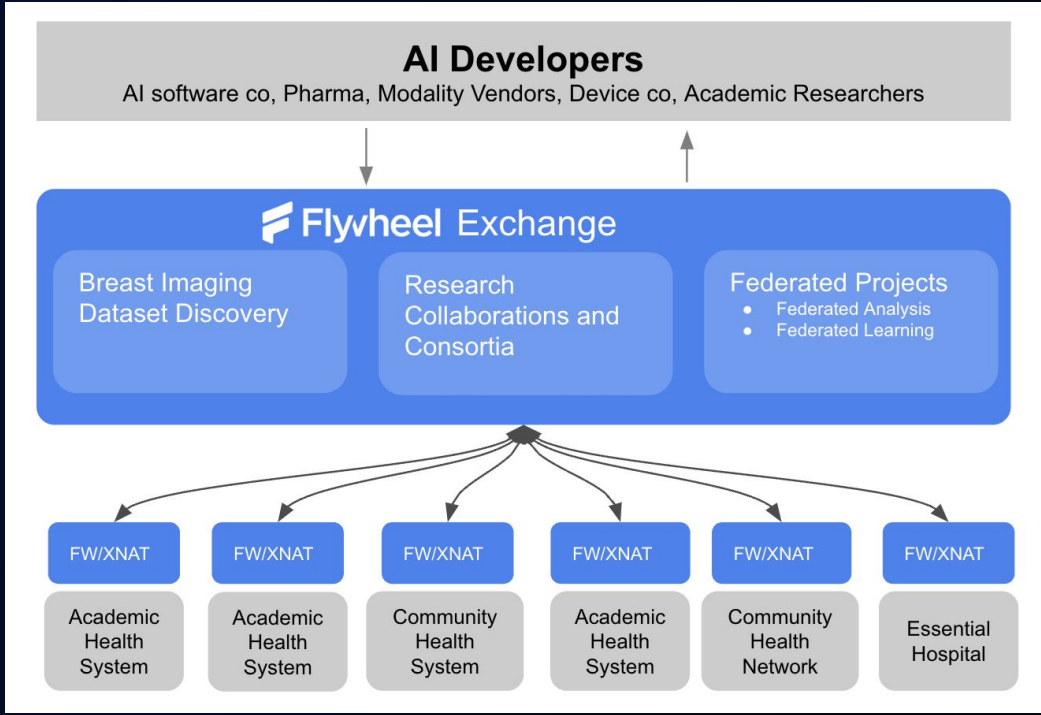
A bit about Flywheel



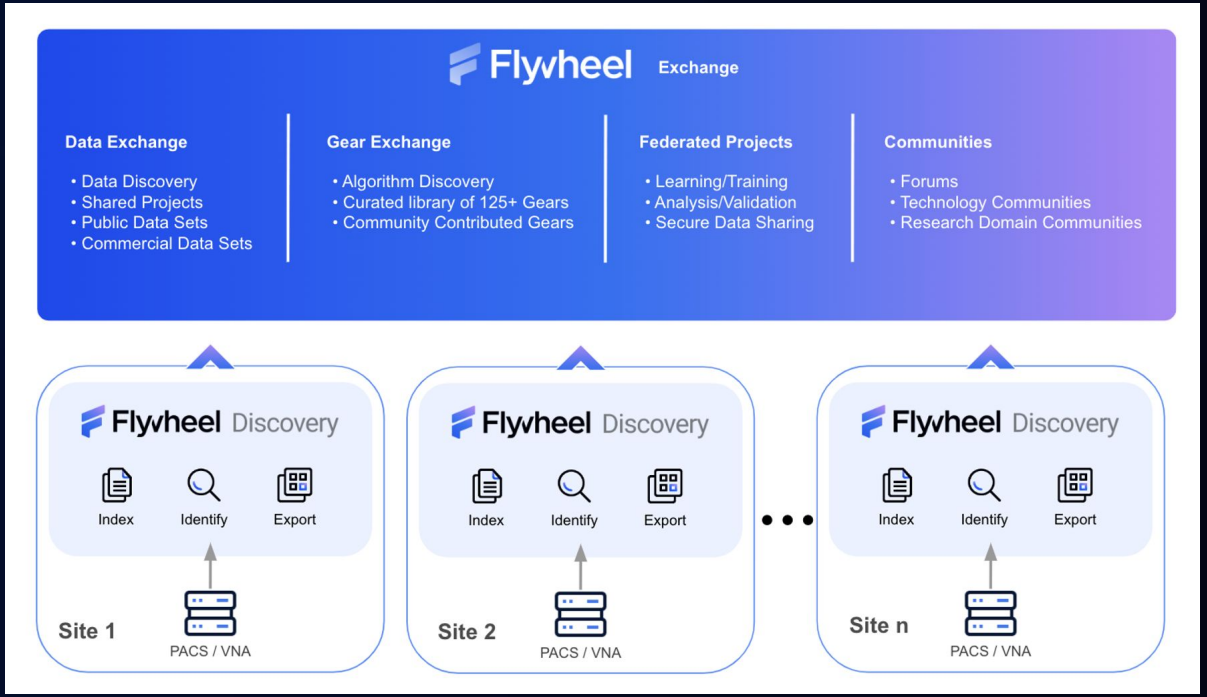
A bit about Flywheel



A bit about Flywheel

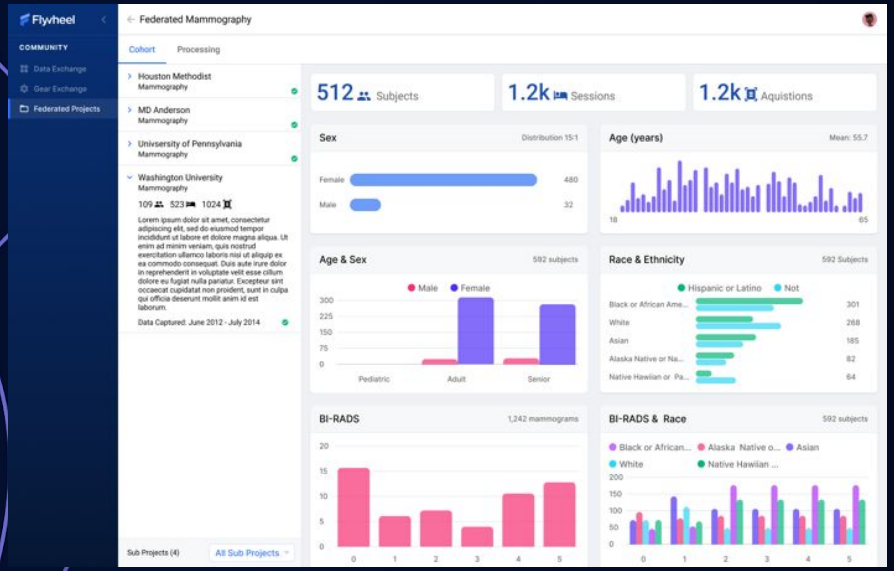


A bit about Flywheel



A bit about Flywheel

2-year $2m NCI contract will build the breast cancer network!



NCI Contract Objectives

1. *Data*: Geographically, demographically representative patient network
2. *Platform*: Federated data discovery and AI development & validation
3. *Governance*: Secure data management w/ differential privacy, provenance, and auditability.

Clinical Data Partners

- 10+ AMCs
- + OneMedNet
- + America's Essential Hospitals

XNAT in the context of Flywheel

- Ongoing development and support of XNAT has moved from WashU to Flywheel
  - NIH R01 grant officially renewed at Flywheel (Sept 1, 2022 – Aug 30, 2026)
  - XNAT core development team (mostly) moved to Flywheel.
  - Dan lives half-time at Flywheel
- Unified XNAT development w/ coherent commercial open source strategy.
- XNAT site engagement in Flywheel initiatives (e.g. Exchange).
- Path to ongoing sustainment beyond NIH funding.

XNAT in the context of Flywheel

- Ongoing development and support of XNAT has moved from WashU to Flywheel
  - NIH R01 grant officially renewed at Flywheel (Sept 1, 2022 – Aug 30, 2026)
  - XNAT core development team (mostly) moved to Flywheel.
  - Dan lives half-time at Flywheel
- Unified XNAT development w/ coherent commercial open source strategy.
- XNAT site engagement in Flywheel initiatives (e.g. Exchange).
- Path to ongoing sustainment beyond NIH funding.

XNAT in the context of Flywheel

- XNAT R01 (NIBIB) is renewed at Flywheel through 2026.
- XNAT U24 (NCI: I3CR) was renewed through 2025.
- XNAT U24 (NCI: PIXI) was funded in 2025.
- Foundation grant (TWCF: Lab notebooks) funded through 2023.
- SBIR (NCI: Intelligent Anonymization) funded through 2023.
- SBIR (NCI: Breast Cancer Federation) funded through 2024.

XNAT sustainment is a community endeavor

UCL
ICR The Institute of Cancer Research
NCITA National Cancer Imaging Translational Accelerator
SyneRBI
Health+Bioscience IDEAS
Flywheel

XNAT sustainment is a community endeavor

THANKS TO THESE GUYS!!!

UCL
ICR The Institute of Cancer Research
NCITA National Cancer Imaging Translational Accelerator
SyneRBI
Health+Bioscience IDEAS
Flywheel