

BIRN Pathology Workbench and Virtual Slide Tools



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BIRN Overview

- The main goal of the BIRN is to enable collaborative bioscience/biomedicine
- share data/tools :
 - data movement infrastructure
 - provide security and user management
 - query across disparate data sources
 - processing/analysis workflows

Technical Approach

- Bottom up, not top down
- Focus on user requirements
- Create re-usable solutions
- Avoid “Big Design Up Front”

Capability Model

- Software and services are only useful if they do things that scientists need.
- BIRN's capabilities are defined in terms of **problems and solutions**, not in terms of software and services

Dissemination Model

- Different problems require different kinds of solutions. BIRN ...
 - *operates services* for users
 - *provides kits* for project teams to deploy services for their members
 - *provides downloadable tools* for individuals to use on their own
- Understanding deployment needs is part of defining the problem to be solved.



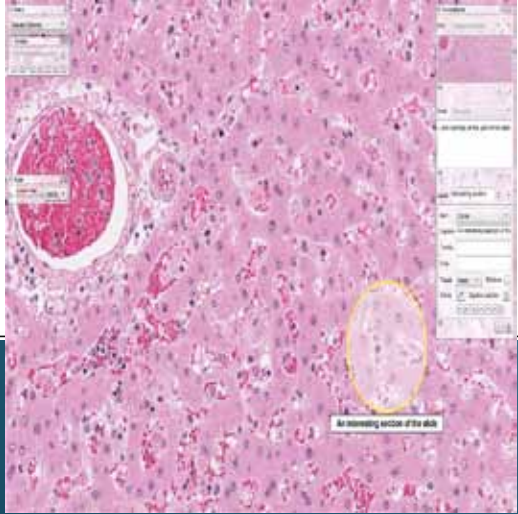
Pathology Workbench

BIRN Pathology Workbench

BIRN BIRN Pathology Workbench Welcome, helmer [Change Password](#) / [Log Out](#)

[Home](#) | [Search](#) | [Subject](#) | [Case](#) | [Specimen](#) | [System](#) | [Organ](#) | [Topo. Location](#) | [Disease Process](#) | [Disease Name](#) | [Etiology](#) | [Morphology](#)

Search Results

Image Description	Accession ID	Subject ID	Case ID	Specimen ID	Diseases
		A-1111	A-1111-C1	A-1111-C1-S1	RINGWORM, NOS (D-05750)
 		B-111	B-111-C1	B-111-C1-S1	ENTERITIS, NOS (D-41704) Yellow fever, unspecified (C0043395)

BIRN Development Team

- USC's Information Sciences Institute:
- Robert Schuler
- David E. Smith
- Gowri Kumaraguruparan
- Ann Chervenak
- Anne D. Lewis
- Dallas M. Hyde
- Carl Kesselman

Motivation

- Collaboration
 - Share pathology data across sites
 - Allow users to search across the entire participating network from a single request
- Imaging
 - Instant access to whole slide images over the web
 - Rich annotation capabilities
 - Minimal client-side software
- Security
 - Local storage and data entry
 - Control over which data to publish

Challenges - Collaboration

- Application data schema and ontology differences
 - Differences even between labs within single organization
 - Requirements change as pathologists gain experience with the system
- Proprietary and closed architectures
 - Limited data sharing
 - Difficult to integrate applications together
- **Distributed system with flexible data schema and ontology to easily share data**

Challenges - Image Size

- Large size of digital slide images
- Low network bandwidth
- **Images must be instantly viewable without full download**



**1/4th megapixel
300 KB each**



**14 megapixels
4 MB each**

**80,000 megapixels
40 GB each**

Challenges - Image Format

- No standard data or whole slide image format in wide use
- Multiple, closed image formats
- Vendor-specific imaging clients
- Pixel data, annotations, and metadata must be converted to a common format



Challenges - Security

- Sensitive data sets
 - Regulatory requirements
 - e.g. HIPAA
 - Protect access to data
 - Even to other parts of the organization
- Network firewalls
- Retain control over local environment
- Data must be protected, maintained locally, and selectively published

Related Systems

No reusable infrastructure for digital pathology networks

Standalone virtual slide servers
OMERO

Online digital pathology resources
Pathbase mutant mouse database
Zebrafish Atlas

No whole slide image and annotation sharing

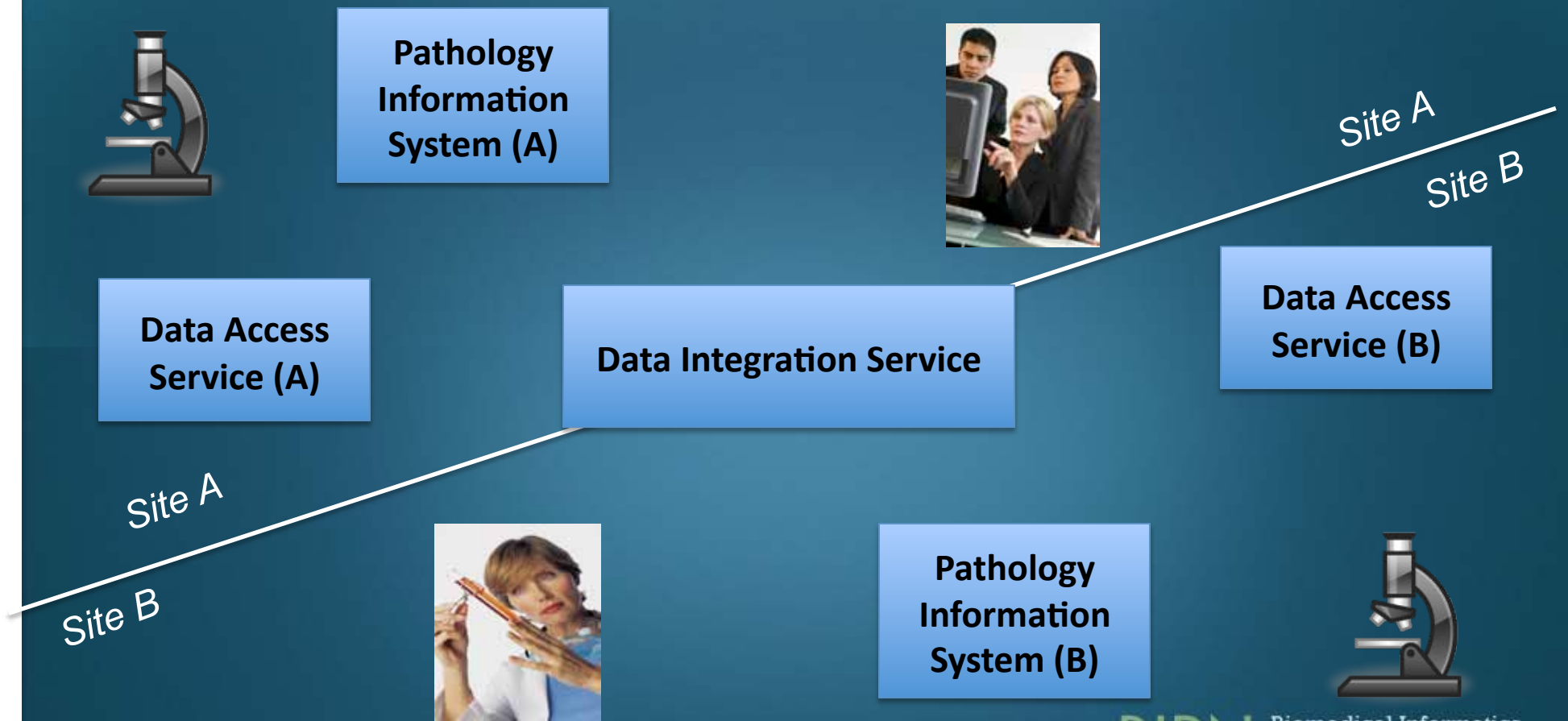
Specimen Inventory Management
caTissue

Neuroimaging Systems
Human Imaging Database (HID)
eXtensible Neuroimaging Archive Toolkit (XNAT)

Limited platform and image support

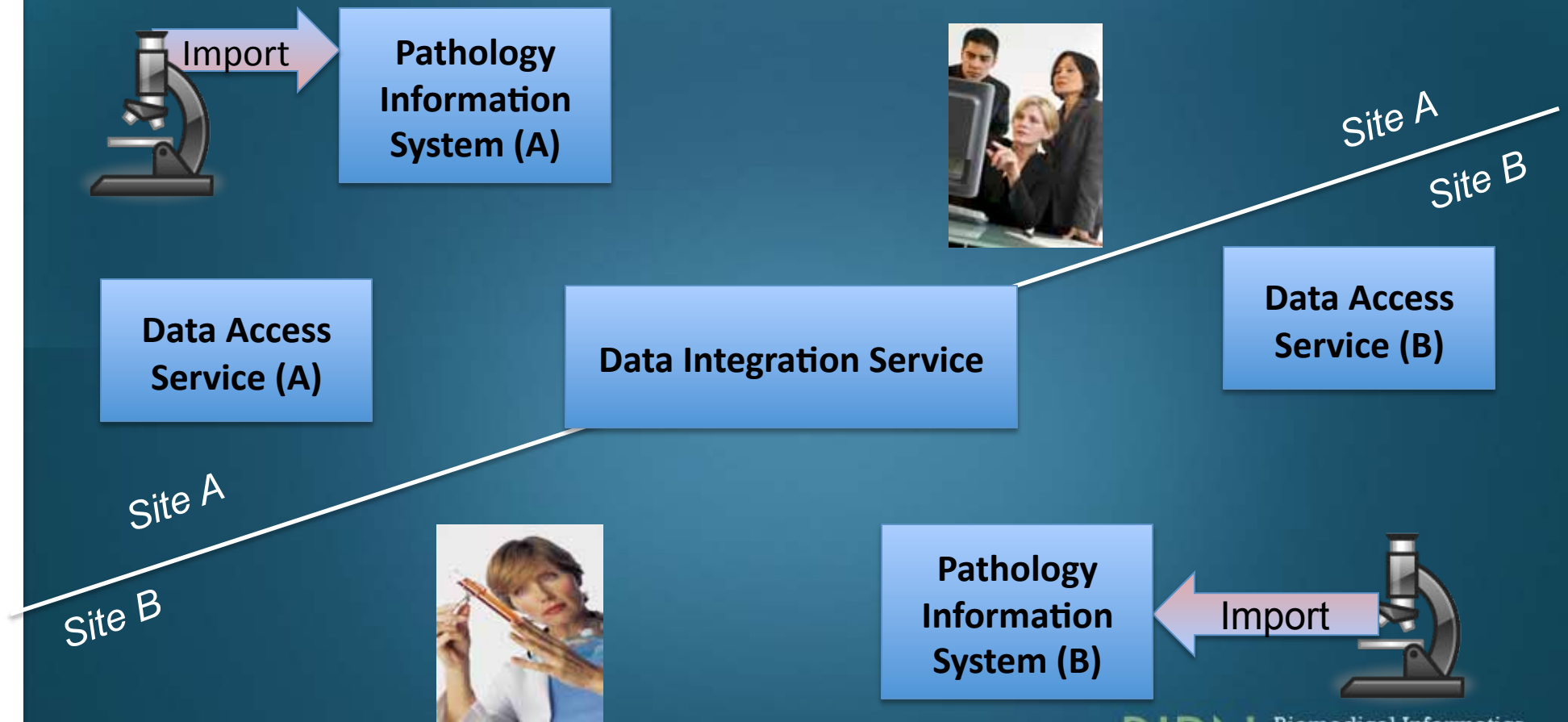
Scanner Vendor Systems
Olympus OlyVIA
Aperio ImageScope

Architecture Overview



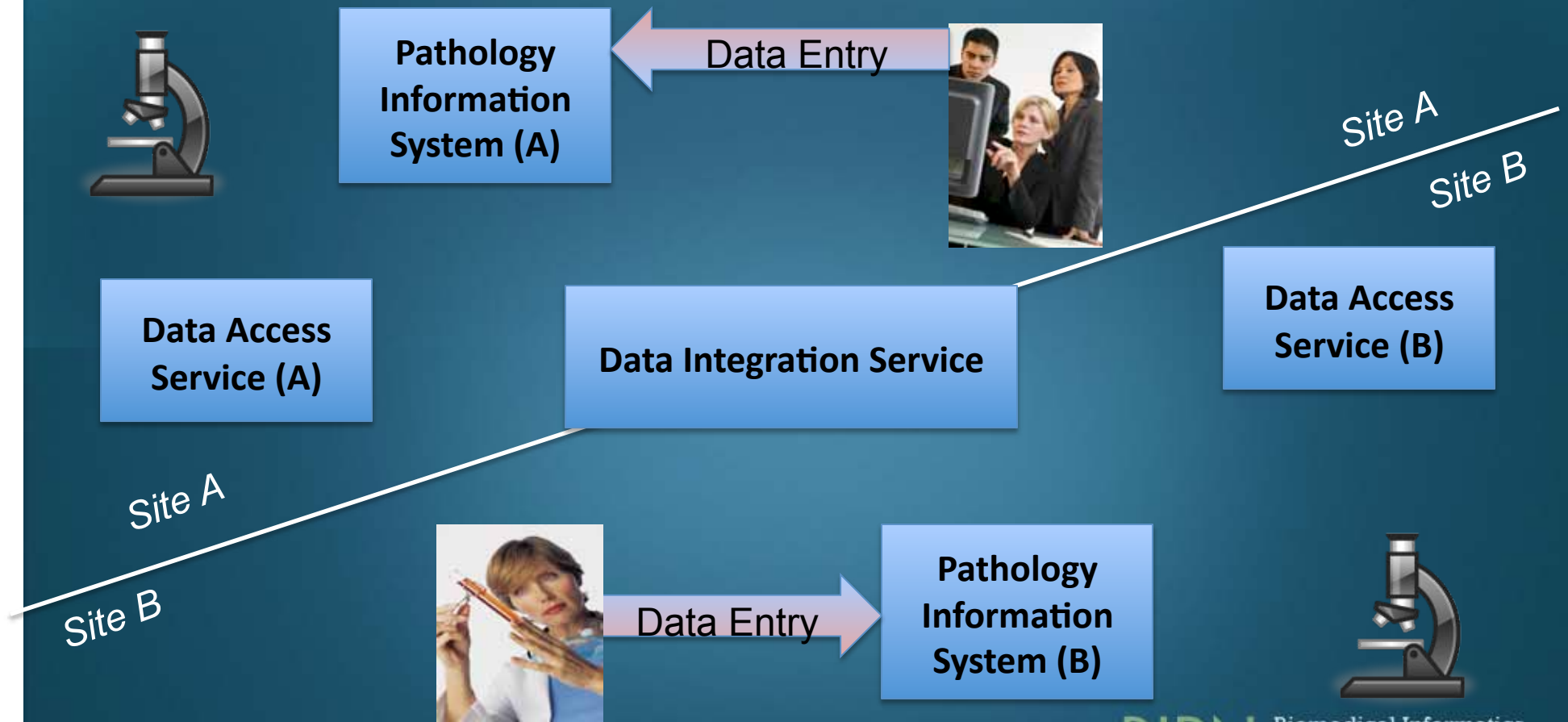
Architecture Overview

Scan images at local centers



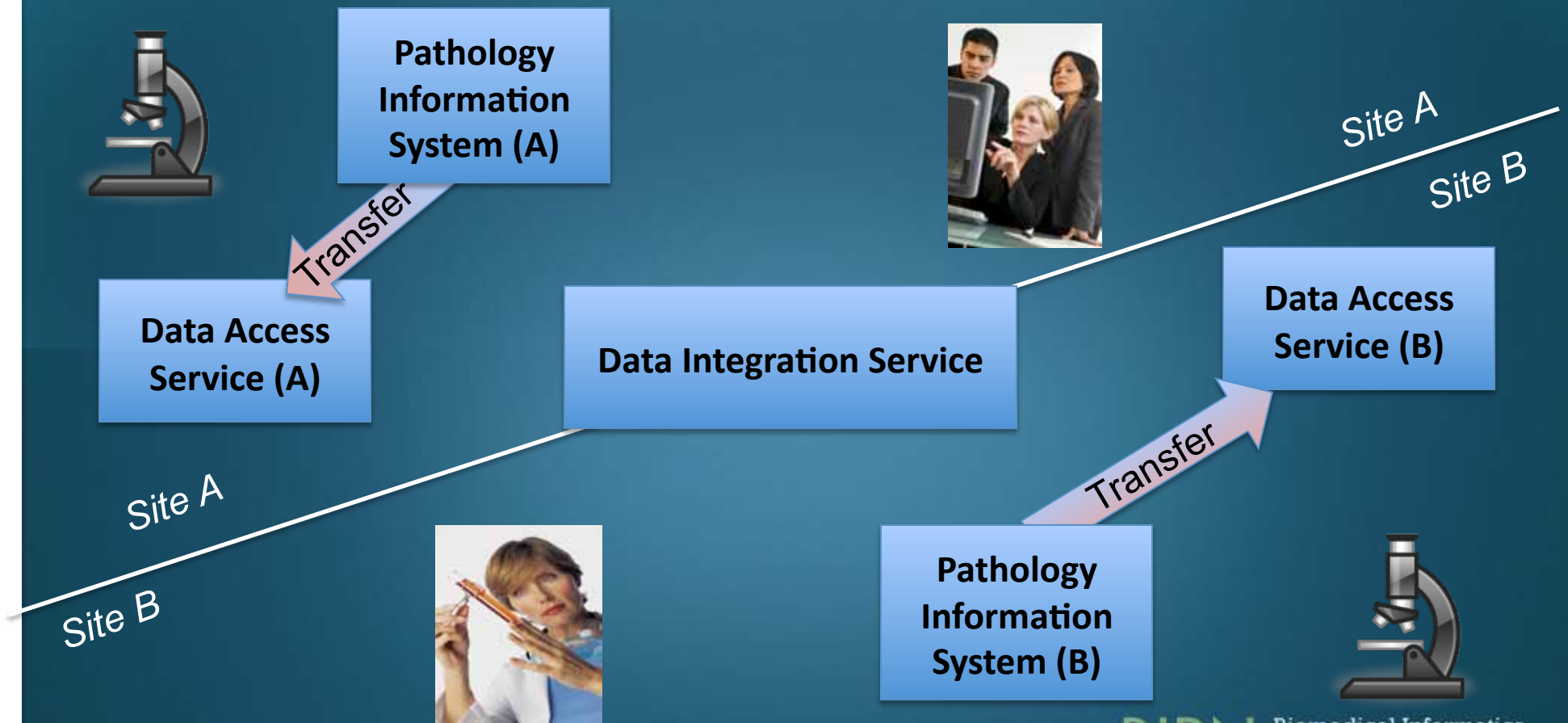
Architecture Overview

Curate data at local centers



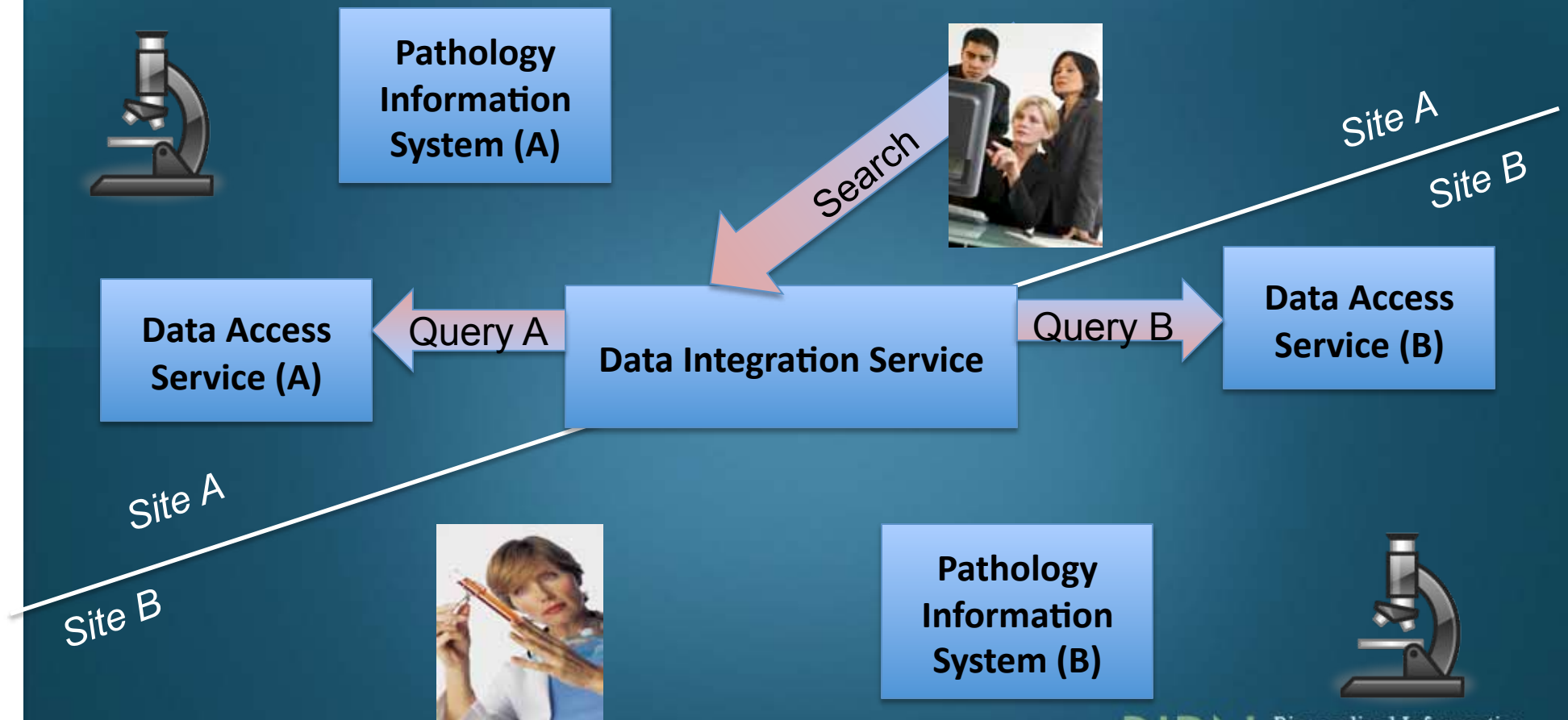
Architecture Overview

Push published data to access services

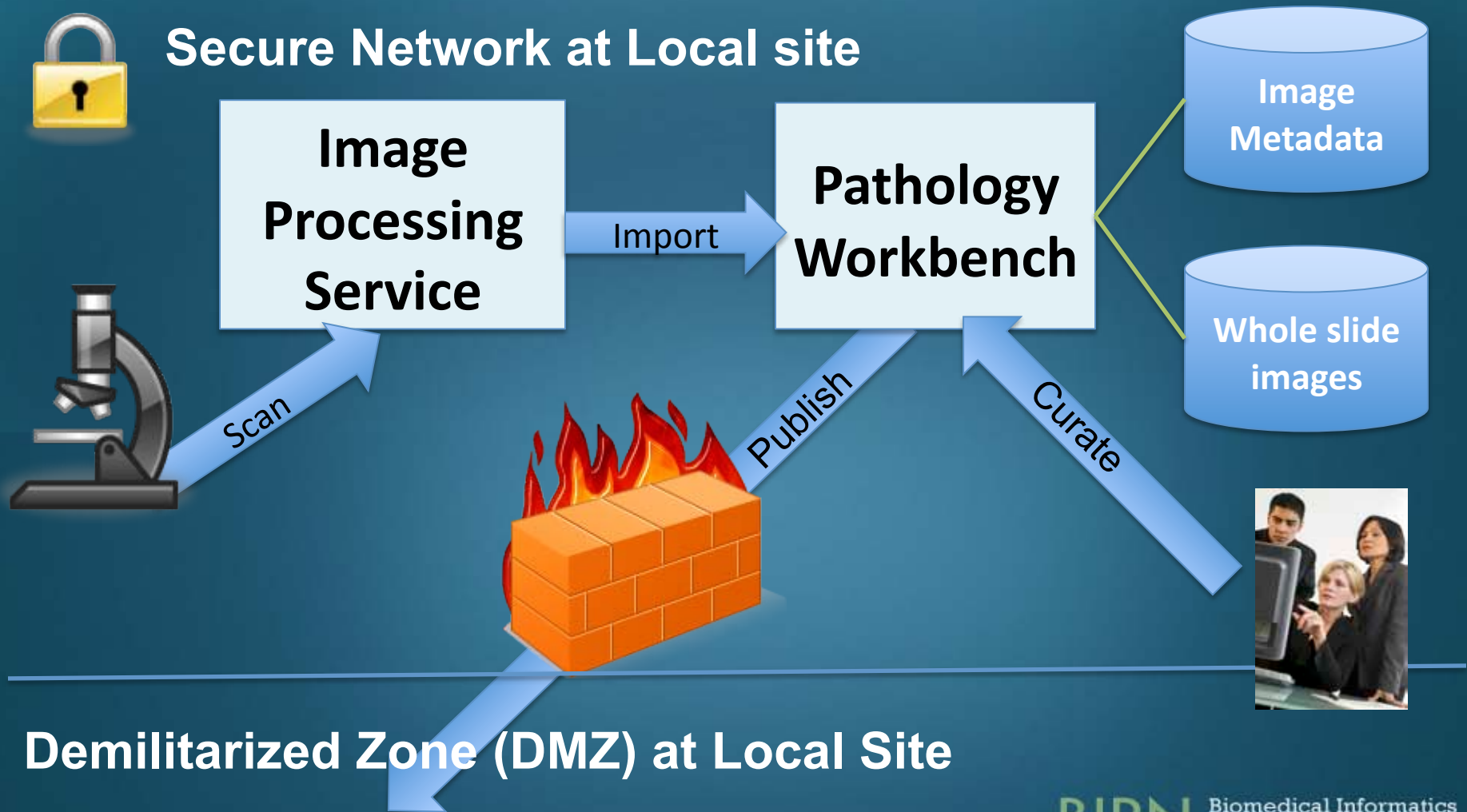


Architecture Overview

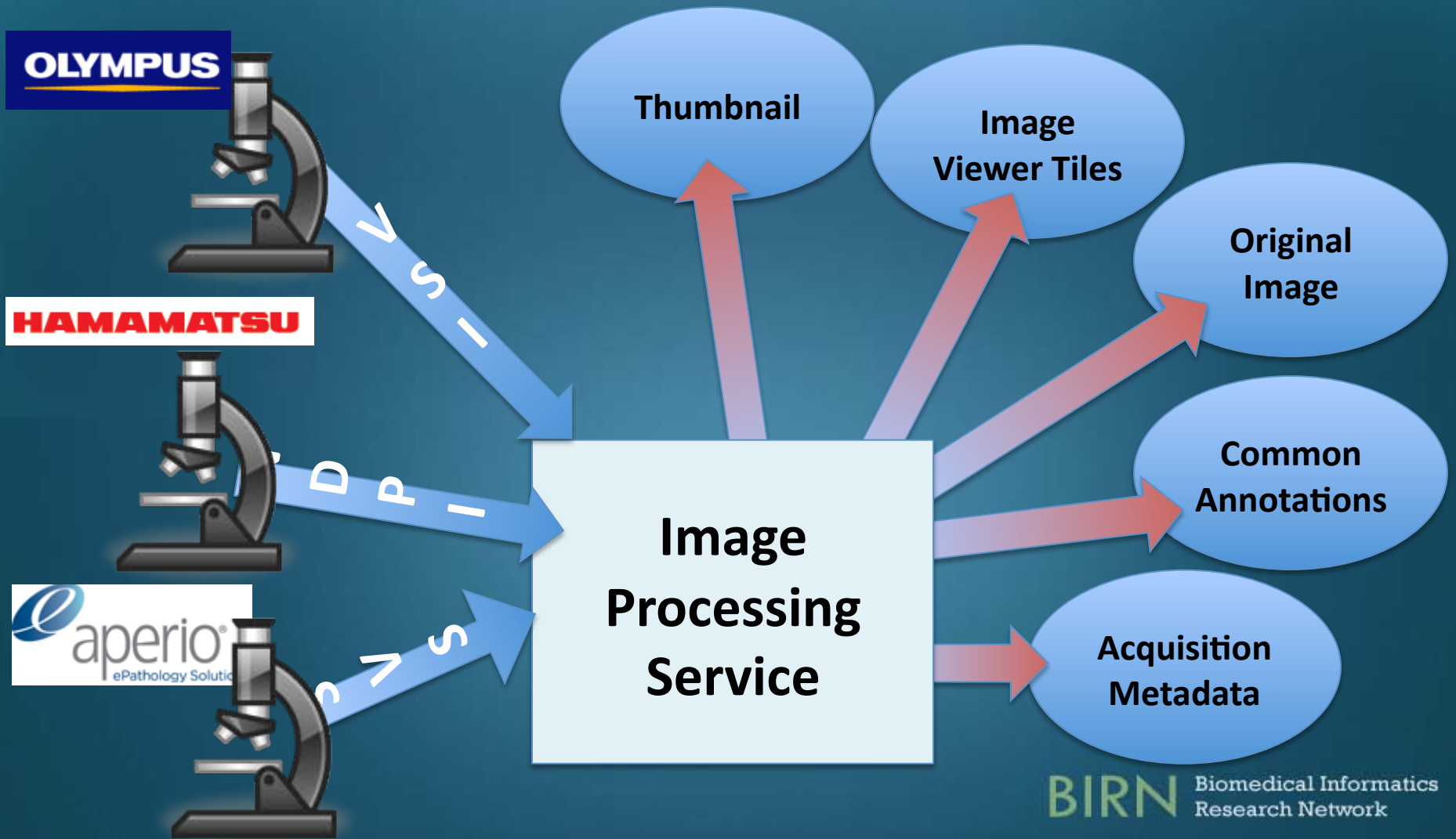
Search for data across all sites



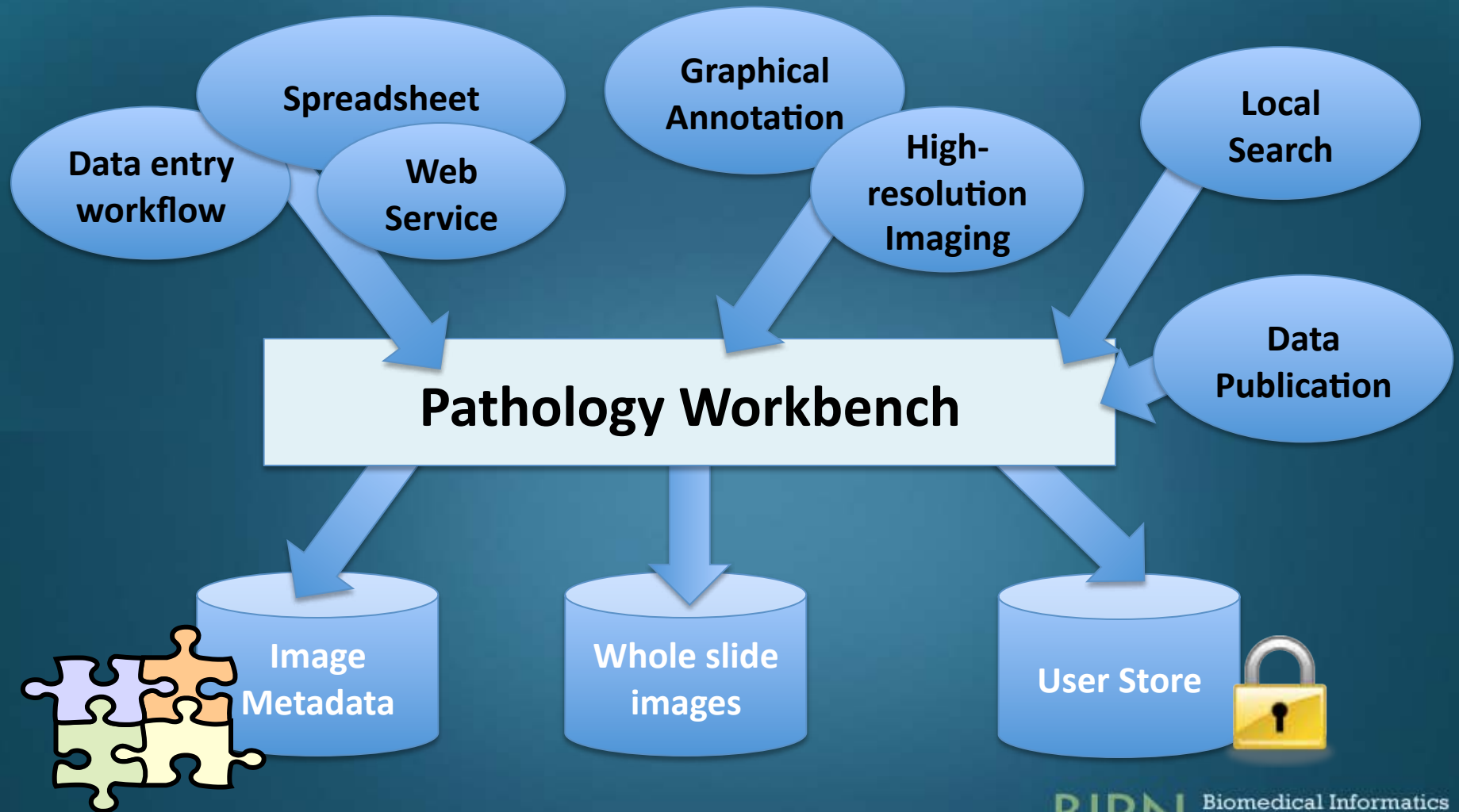
Pathology Information System



Pathology Information System - Image Processing Service



Pathology Information System - Pathology Workbench



Pathology Information System - Pathology Workbench

Case A-1111-C1 - Case History: Case/Clinical Overview

Case ID: A-1111-C1 Age (in years): 1 Age Category: Juvenile
Case Date: 2011-11-02 Age (in days): Body Weight (kg): 12

Procedure(s) Available

Q: [Search Box]

CSF COLLECTION (P-1C1B)
ABORTION, INDUCED, NOS (P-1750)
ACID FAST (P-YY13 I)

Class(es)

Filter your search on the [Filter Icon]

PATIENT STATUS DETERMINATION UNCHANGED (P-0610)

Case History Comments

Published?

Save Save and Add Disease

Diseases for Case A-1111-C1: Case History

Add Disease

ECHINOCOCCOSIS, NOS

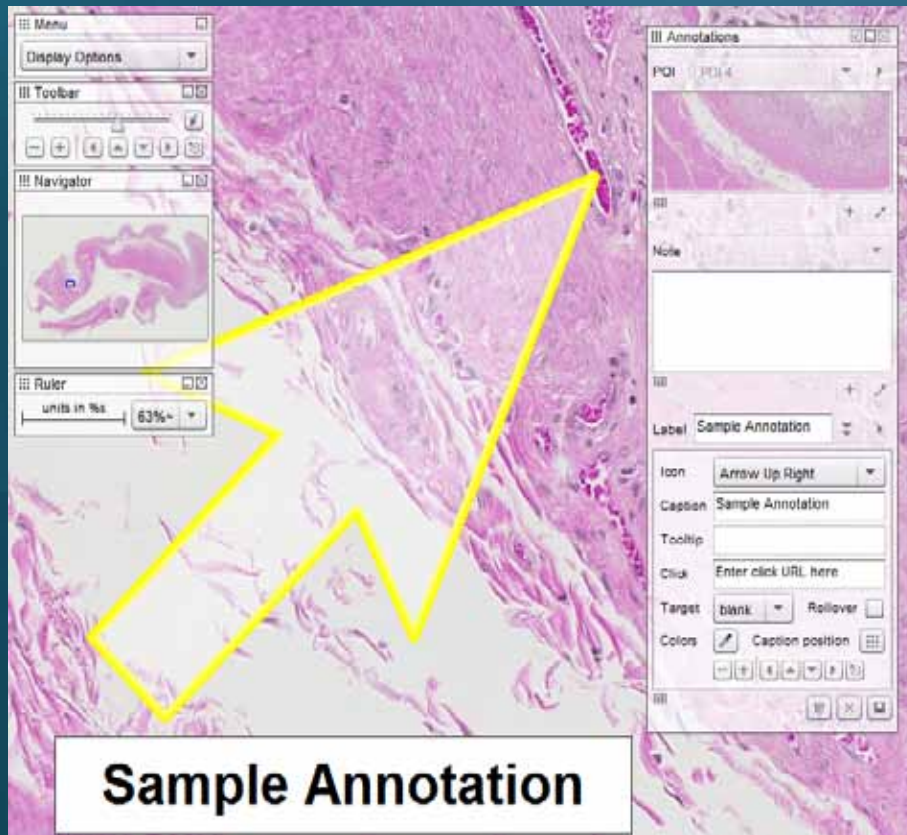
Disease: ECHINOCOCCOSIS, NOS (P-0810) Etiology: QUININE (E-7672)

Disease Processes: immune-mediated, infectious, inflammatory, inherited

Transmission: [Empty Field]

- Secure
 - Local access and data administration
 - Authenticate with username and password
 - Application and image-level permissions
- Flexible, complex data schema
- Data entry methods
 - Workflow-based web pages
 - Spreadsheet import
 - Web-service (REST)



Pathology Information System - Pathology Workbench



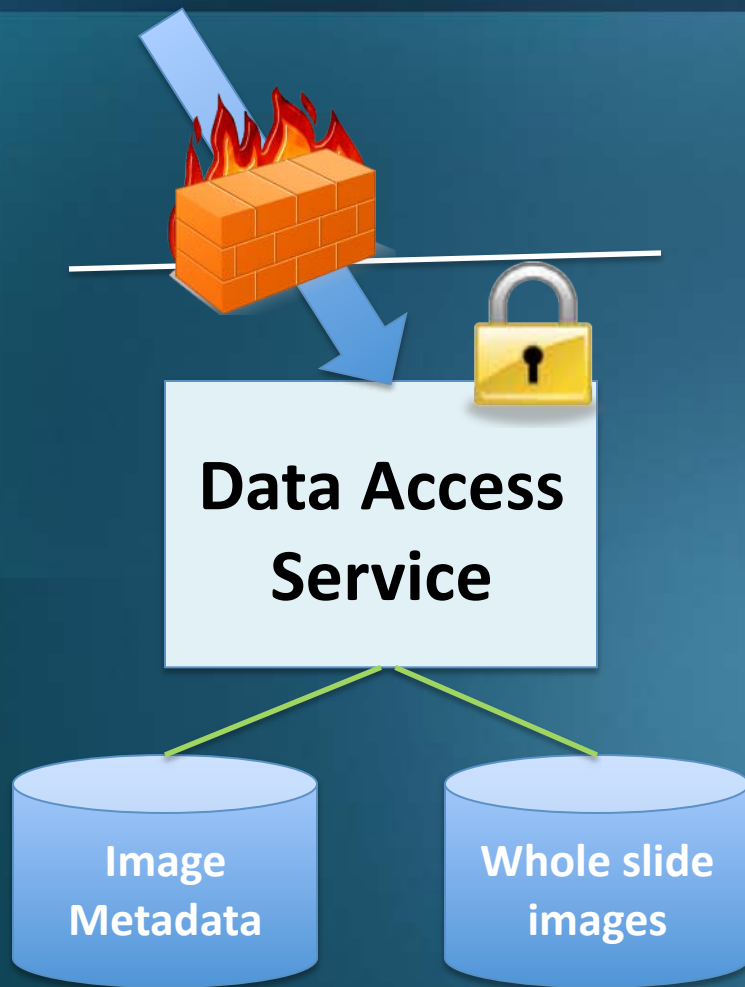
- Zoomify Enterprise Viewer
- Image viewing
 - Browser-based, loads instantly
 - Progressive-rendering
 - View whole image at low resolution
 - Zoom to high resolution area
- Annotations
 - Mark, label points of interest
 - Share with other users

Pathology Information System - Pathology Workbench

- Search local data
 - Specific metadata
 - e.g. find all images that belong to a lung specimen
 - Full-text
 - e.g. find all images that contain the phrase “Ringworm” in all metadata
- Publication
 - Choose the data that gets pushed to collaborators

Search Results						
	Image Description	Accession ID	Subject ID	Case ID	Specimen ID	Diseases
			A-1111	A-1111-C1	A-1111-C1-S1	RINGWORM, NOS (D-05750)
	An image from the first subject's case		A-1111	A-1111-C1	None	ECHINOCOCCOSIS, NOS (D-06830)

Data Access Service

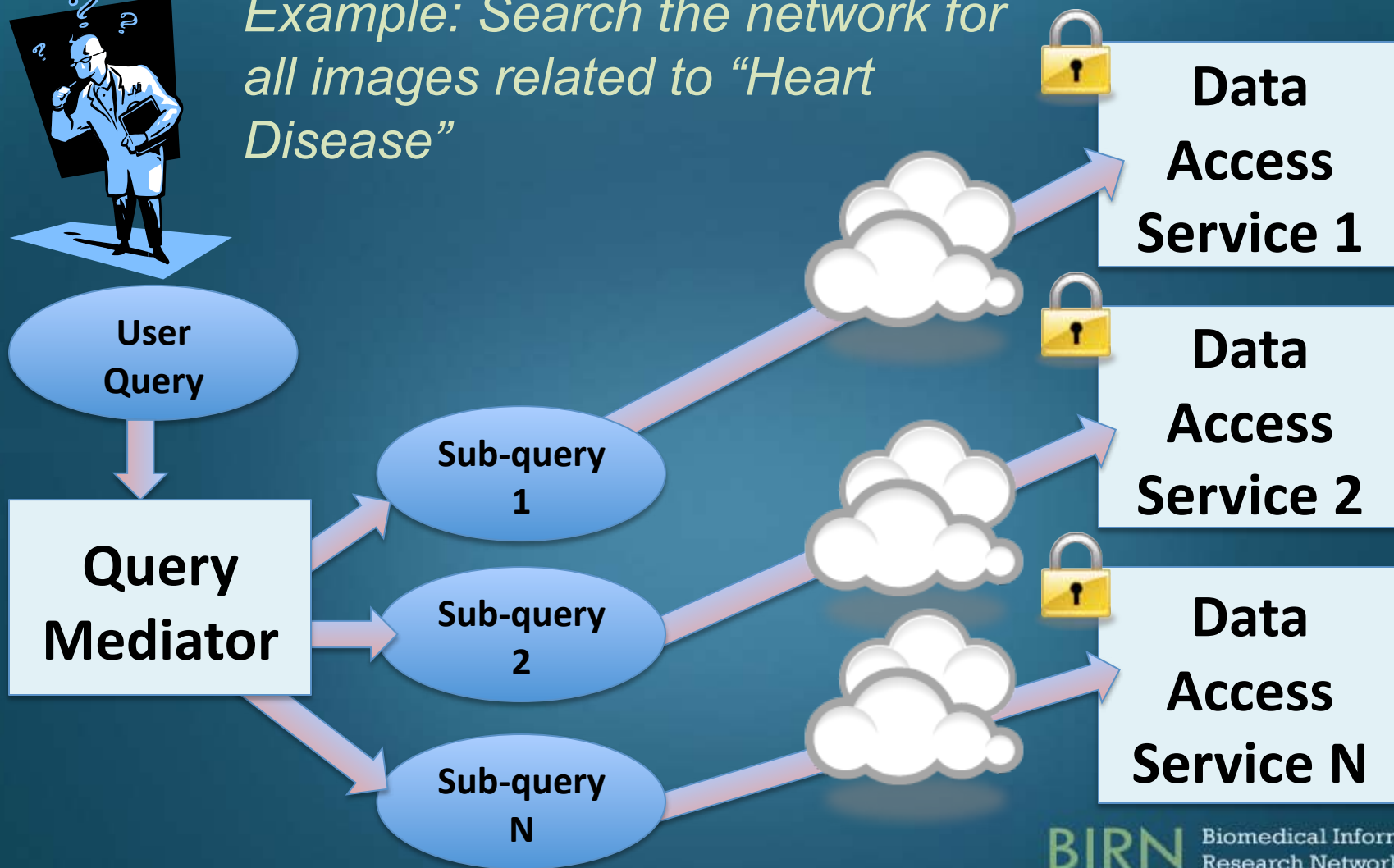


- Operated outside the firewall (DMZ)
- Receives data securely from a single Pathology Information System
 - e.g. using Globus File Transfers (GridFTP) with host or service certificates
- Manages its own copy of metadata and image files

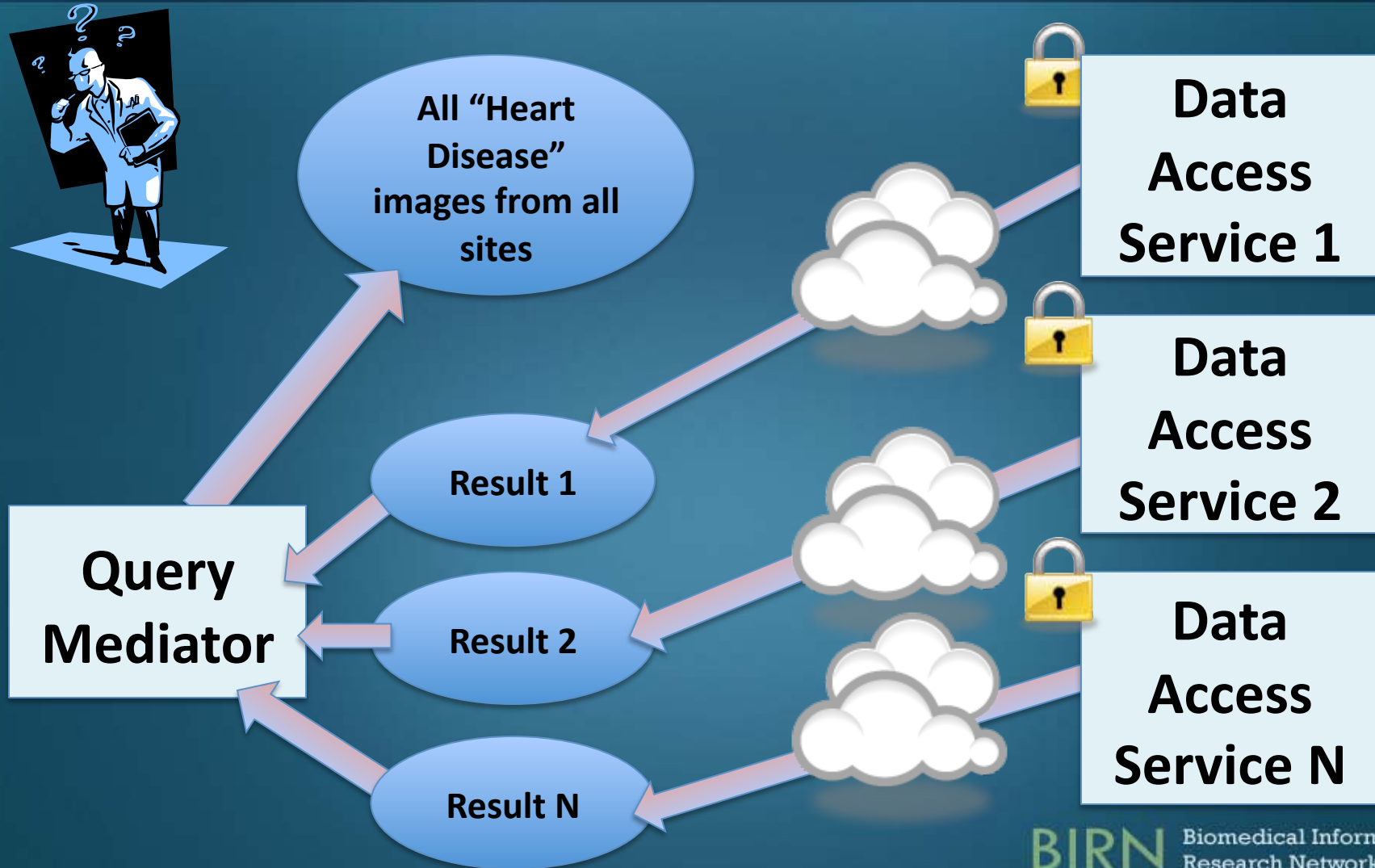
Data Integration Service



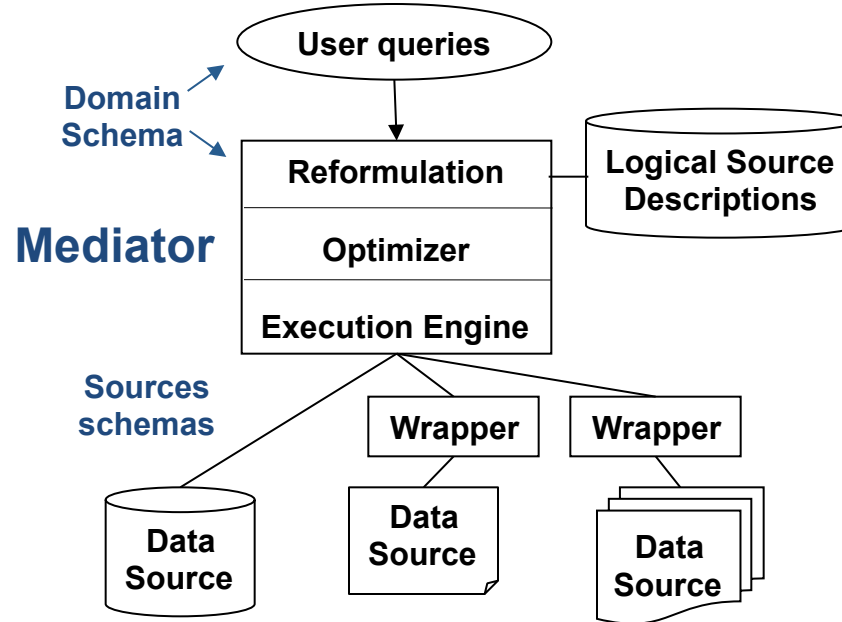
Example: Search the network for all images related to "Heart Disease"



Data Integration Service



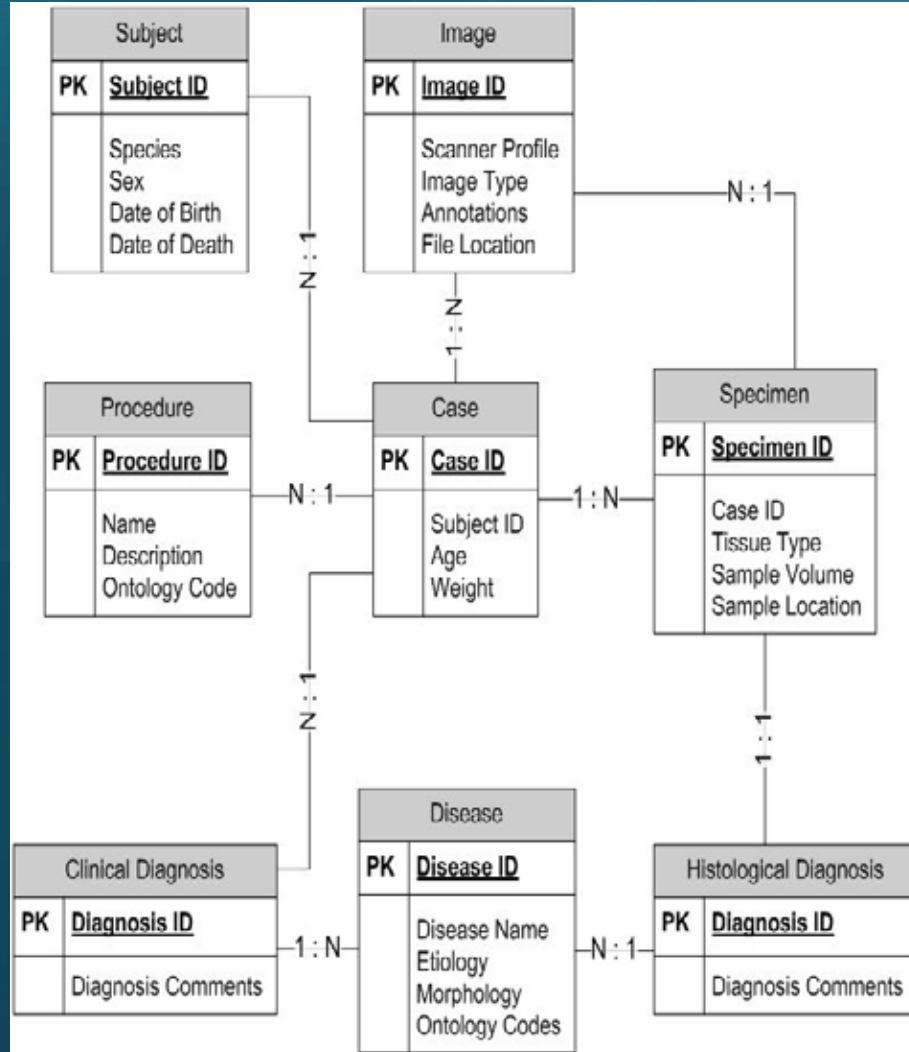
Information Mediator



Testbed - Initial Deployment

- Two Non-Human Primate Research Center (NHPRC) sites
- 27,000+ images processed
 - Olympus VSI, Hamamatsu NDPI, Aperio SVS, JPEG, TIFF
 - Rate of conversion ~1 GB/hour per compressed image data
 - Collection is over 1.5 TB in size
- Pathologists curating data and assigning to images
- Currently publishing data to share with other NHPRC sites

Testbed - Data Schema



- Developed over 18 months
- Identified concepts and relationships
- Rapid database implementation based on schema
- Continual feedback and improvements
- Combination of standard and custom ontologies
 - e.g. SNOMED

Future Work

- Expand beyond initial deployment
- Improve data curation experience
- Further data schema refinement
- Federate between different schemas using the BIRN Mediator
- Image processing automation improvements
 - Scalability
 - Performance
 - Management



Conclusion

- Digital Pathology Network system architecture and implementation met user requirements
 - Flexible, open, decentralized
 - High-resolution whole slide imaging with annotations
 - Rich pathology schema and data workflows
 - Local administrative control
 - Share data with collaborators
- Successful initial deployment
 - Two large-scale research centers
 - Active use by pathologists and related research and support staff
- Learn more about BIRN Pathology:

<http://www.birncommunity.org>