

# Back to the Beginning: SNOMED CT in Surgical Pathology Microscopic Examination

W. Scott Campbell, MBA, PhD

University of Nebraska Medical Center



# Objectives

- Brief overview of surgical pathology
- Introduce whole slide imaging
- Discuss incorporation of image annotation and storage of SNOMED CT expressions
- Current Development Efforts and Status

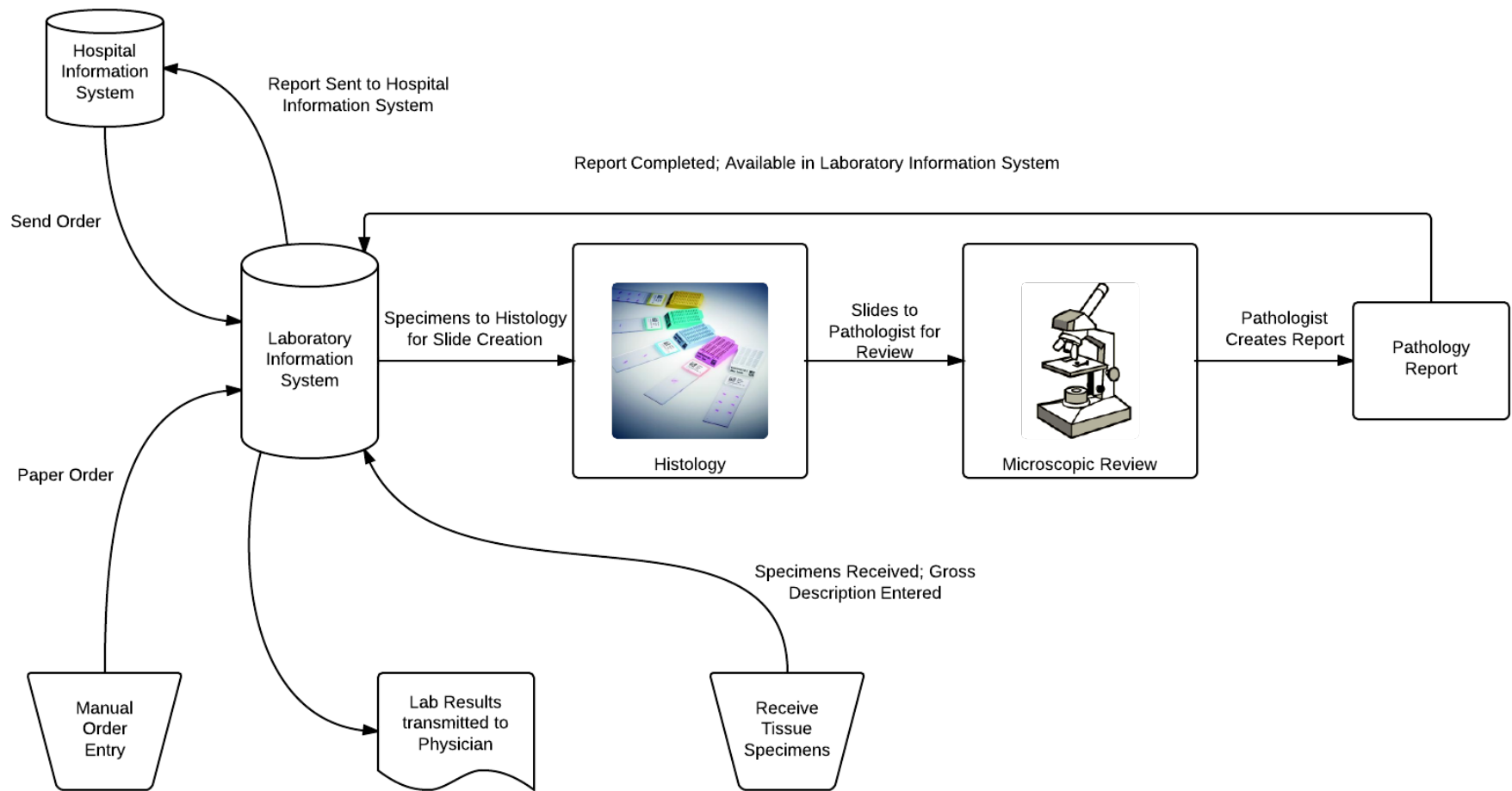


# Pathology - Where it all began

- **SNOP – Systematic nomenclature of Pathology**
  - Classification of tumors in Four axes
  - 1965
- **SNOMED II**
- **SNOMED CT (SNOMED RT/UK CTV3)**
- Used today for: problem lists, procedures, epi  
But.....Histopathology?
- We believe, “Yes!”



# Anatomic Pathology Workflow





# Current Practice

- Pathologist examines slides
- Identifies relevant abnormal tissue morphologies using various staining techniques
- Correlates visual observations and findings
  - Radiology studies
  - Patient history
- Reaches conclusion and generates report with Clinical Findings



# Typical Pathology Report

## Final Diagnosis:

RIGHT BREAST, VACUUM-ASSISTED NEEDLE CORE BIOPSY:

- DUCTAL CARCINOMA IN SITU WITH EXTENSIVE PERIDUCTAL SCLEROSIS AND INFLAMMATION.
- FOCUS SUSPICIOUS BUT NOT DIAGNOSTIC FOR MICROINVASION.
- GROWTH PATTERN: SOLID.
- NUCLEAR GRADE: HIGH.
- NECROSIS: PRESENT.
- MICROCALCIFICATION IN DCIS: YES.

**Microscopic Report:** Performed

- Natural Language
- Not easily computed for knowledge use and reuse
- Microscopic Findings not enumerated



# SNOMED CT for Findings and Observations

A review of 24 breast biopsy case reports and slides yielded 95 unique clinical statements

- 75% of concepts represented by post-coordinated expressions (Situations, Specific morphologies, Finding sites and methods)
- 25% could not be encoded
  - Measurements (Observables Model now addresses)
  - Missing concepts for staining technique
  - Architectural features...
    - Epistimologic?



## Post-Coordinated example: Focal Epithelial Hyperplasia with atypia

Epithelial hyperplasia with atypia |IS A|

404684003|clinical finding|:

{363698007|finding site| = 31737007|structure of small lactiferous ducts|,

116676008|associated morphology| =

**(36949004|focal epithelial hyperplasia| + 44085002|atypia suspicious for malignancy|),**

418775008|finding method| = (252416005|histopathology test|

+104157003|light microscopy| + 104210008|hematoxylin and eosin stain method|))}





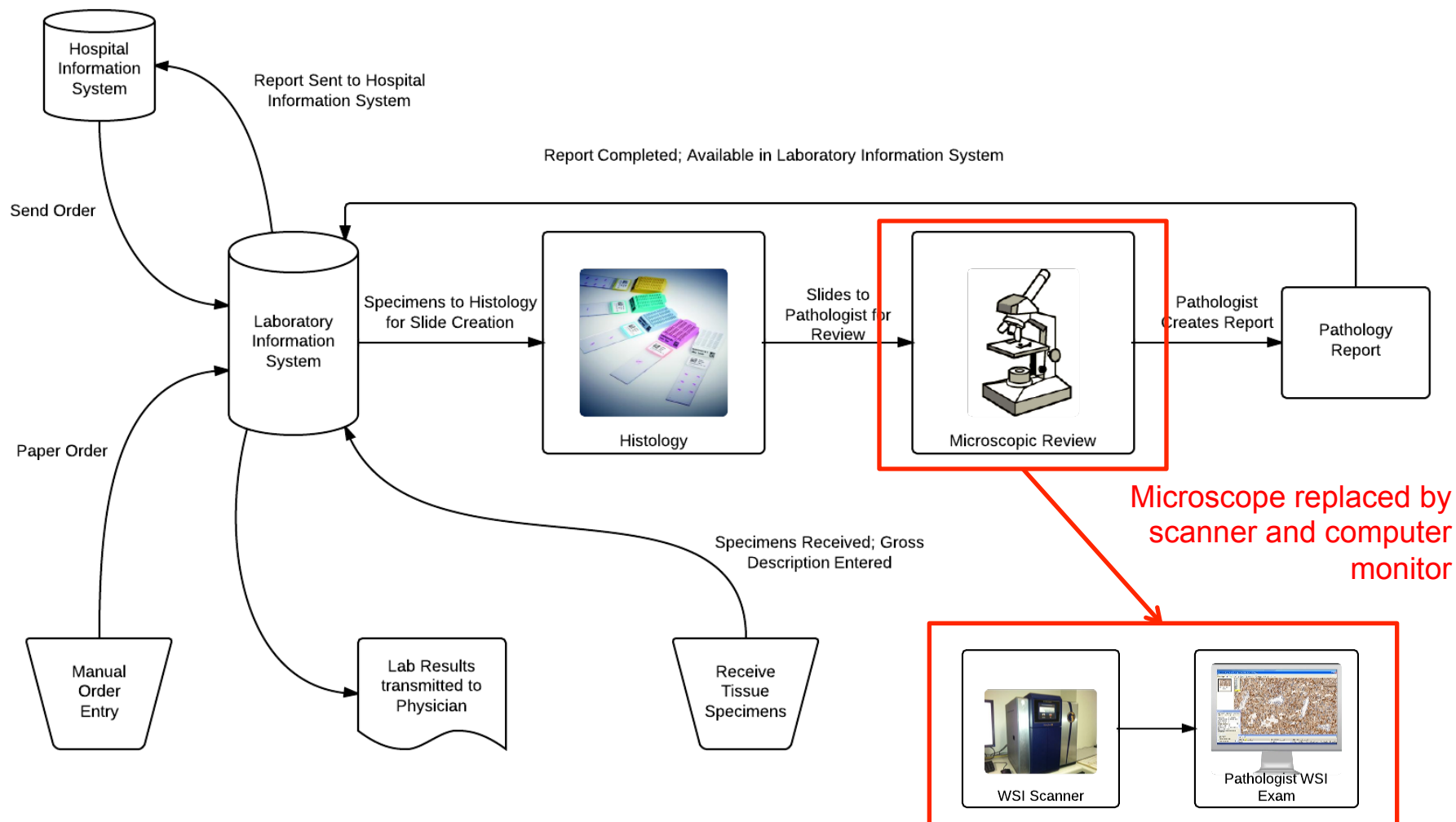
# Requirements of Histopathology Expression

1. Importance of finding site specificity
2. Architectural formations (the objects of interpretations and cognition)
3. Presence, absence and suspicion
4. Methodology
  1. Staining techniques
  2. Bright field, immunofluorescence

Need more inventory of expressions



# Anatomic Pathology Workflow - WSI

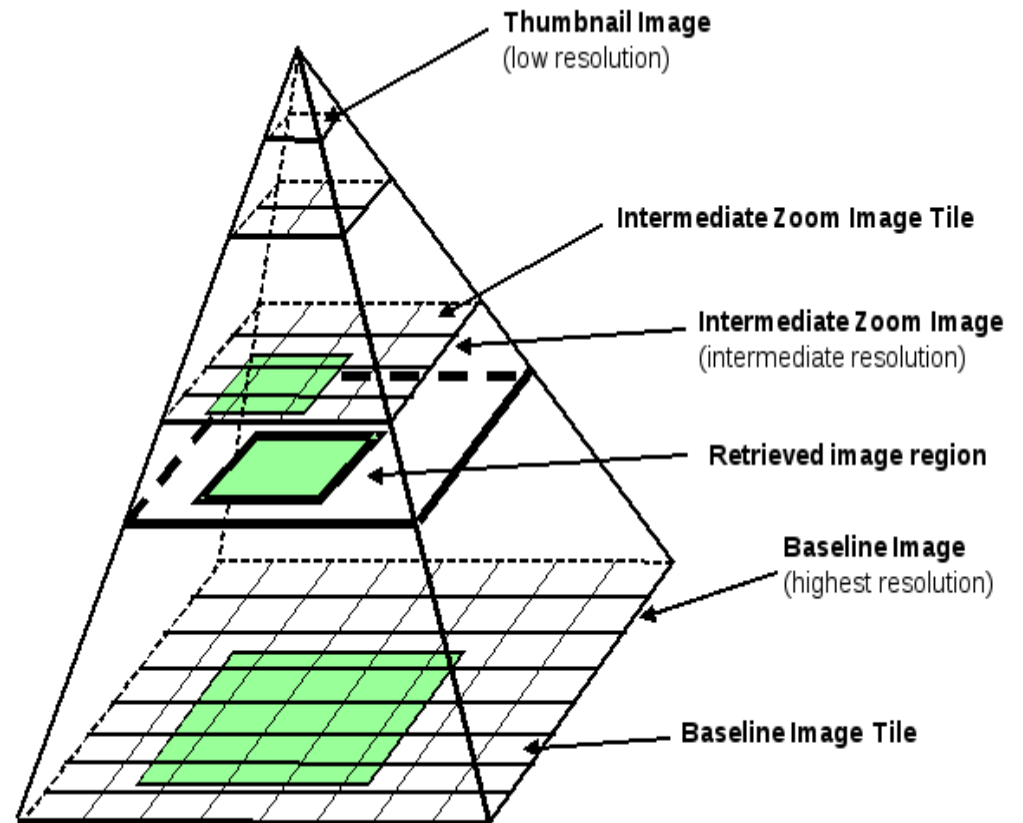




# Whole Slide Imaging Basics

Digital scan of entire (whole) slide

- Image tiles
- Image stitching
- Zoom/Pan
- Large File Size ~1.2GB
- 6 billion pixels per file



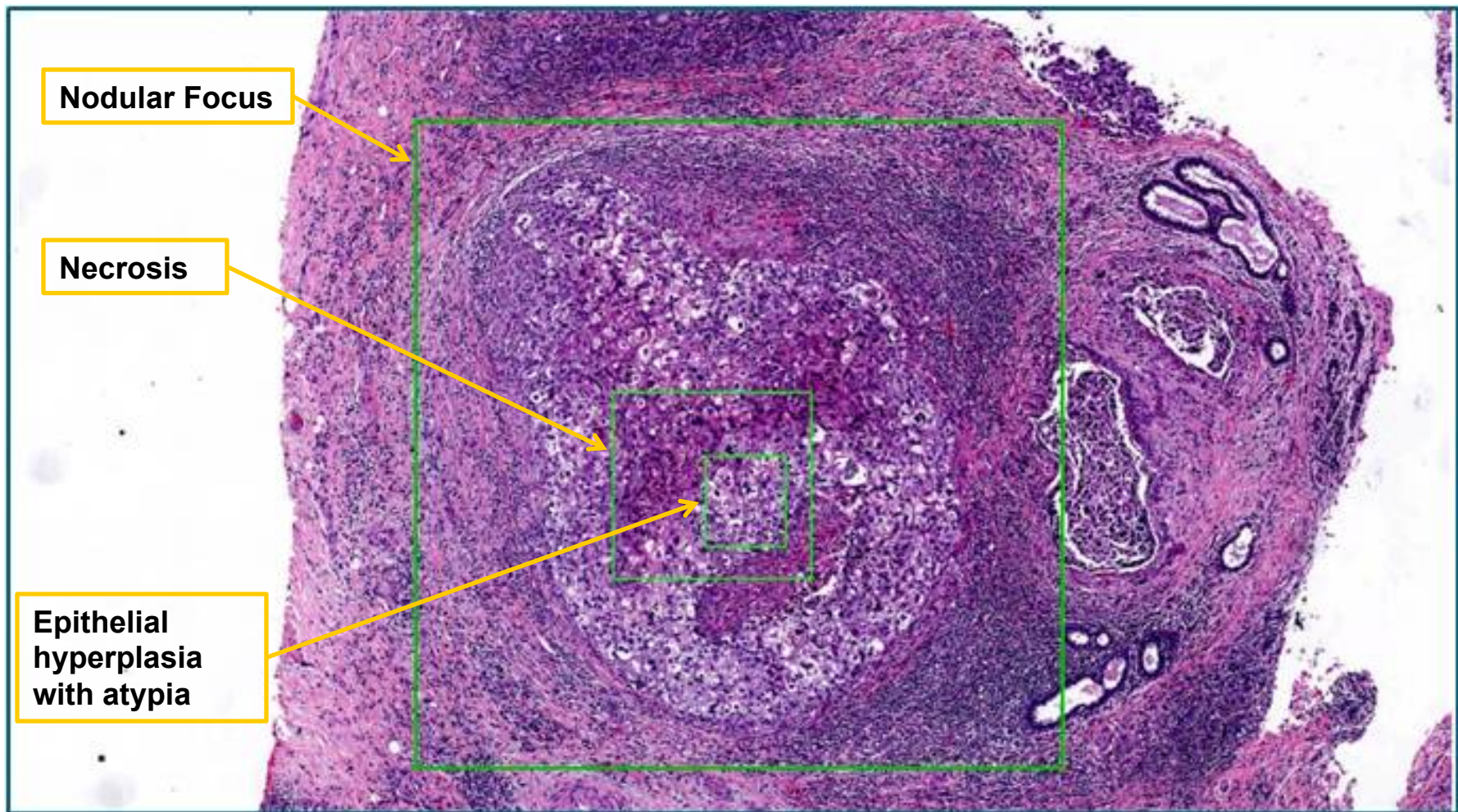


## Whole Slide Imaging as a tool

- WSI allows images of tissue features to be outlined (marked up) and annotated
- Annotations represent inventory of statements
- SNOMED CT expressions can be created for natural language annotations
- WSI provide image artifacts for reference



# Mark up example: Ductal carcinoma of breast





# WSI Annotations (i.e., images metadata)

- Annotation files stored as XML image metadata files
- Provide natural language inventory of clinical utterances
- Provide image exemplars as reference for SNOMED CT expression development

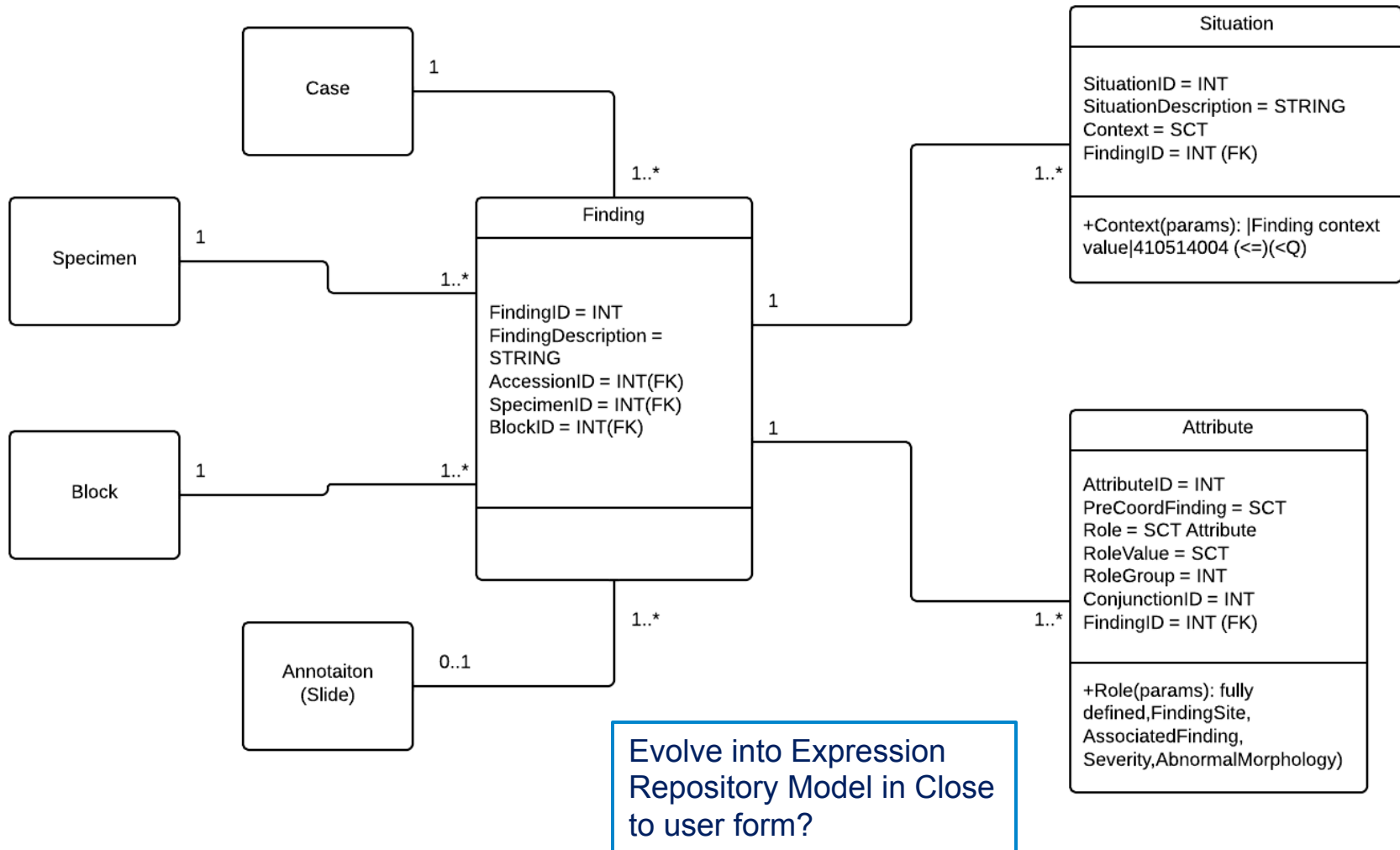


# Storage of SNOMED CT expressions

- Heavy use of post-coordination
- Multiple Hierarchies
  - Clinical Findings
    - Case, Specimen, Block, Slide (?)
  - Observables
    - Slides, image annotations
  - Situations
- Flexible Architecture



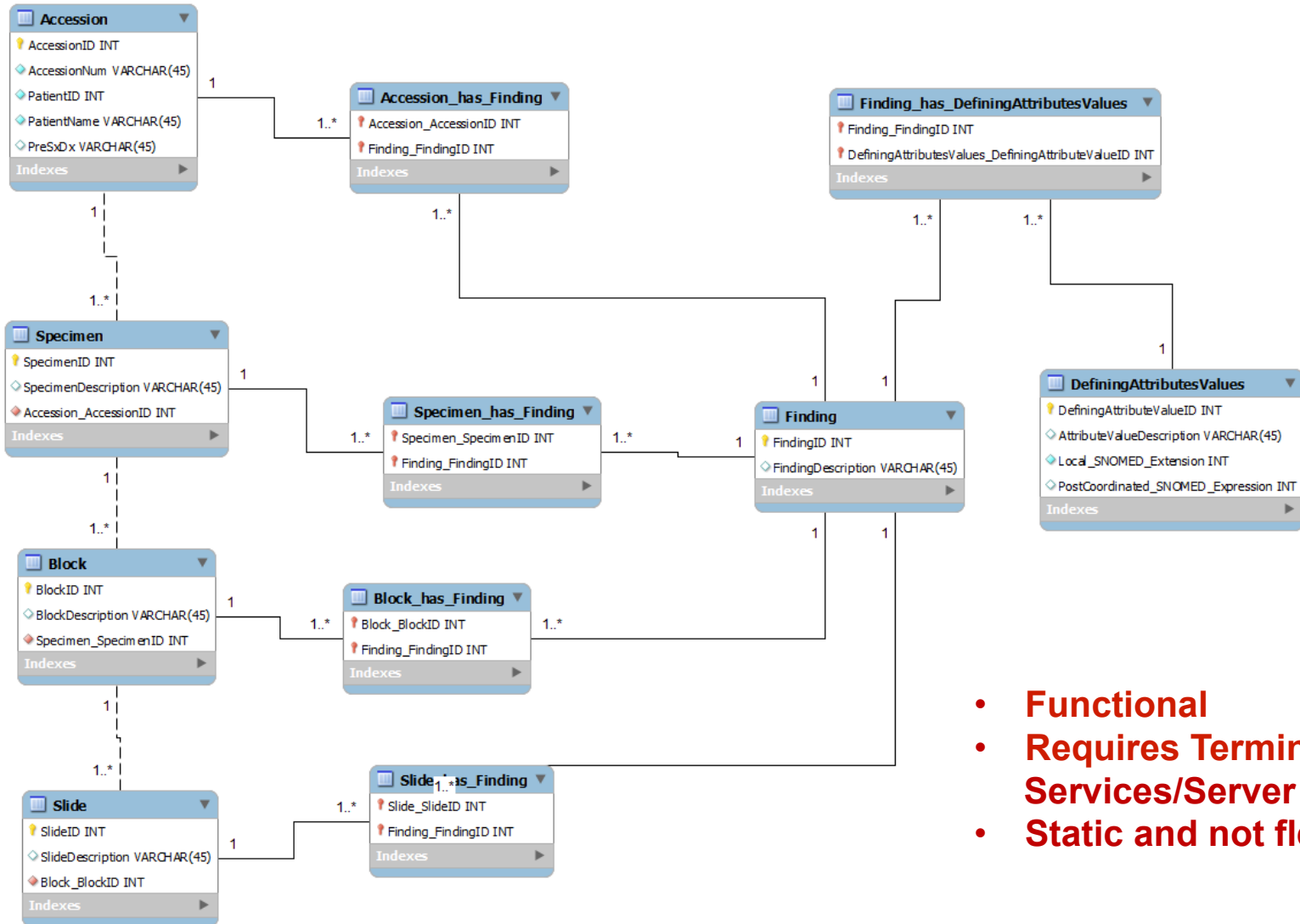
# Clinical Finding Storage Model







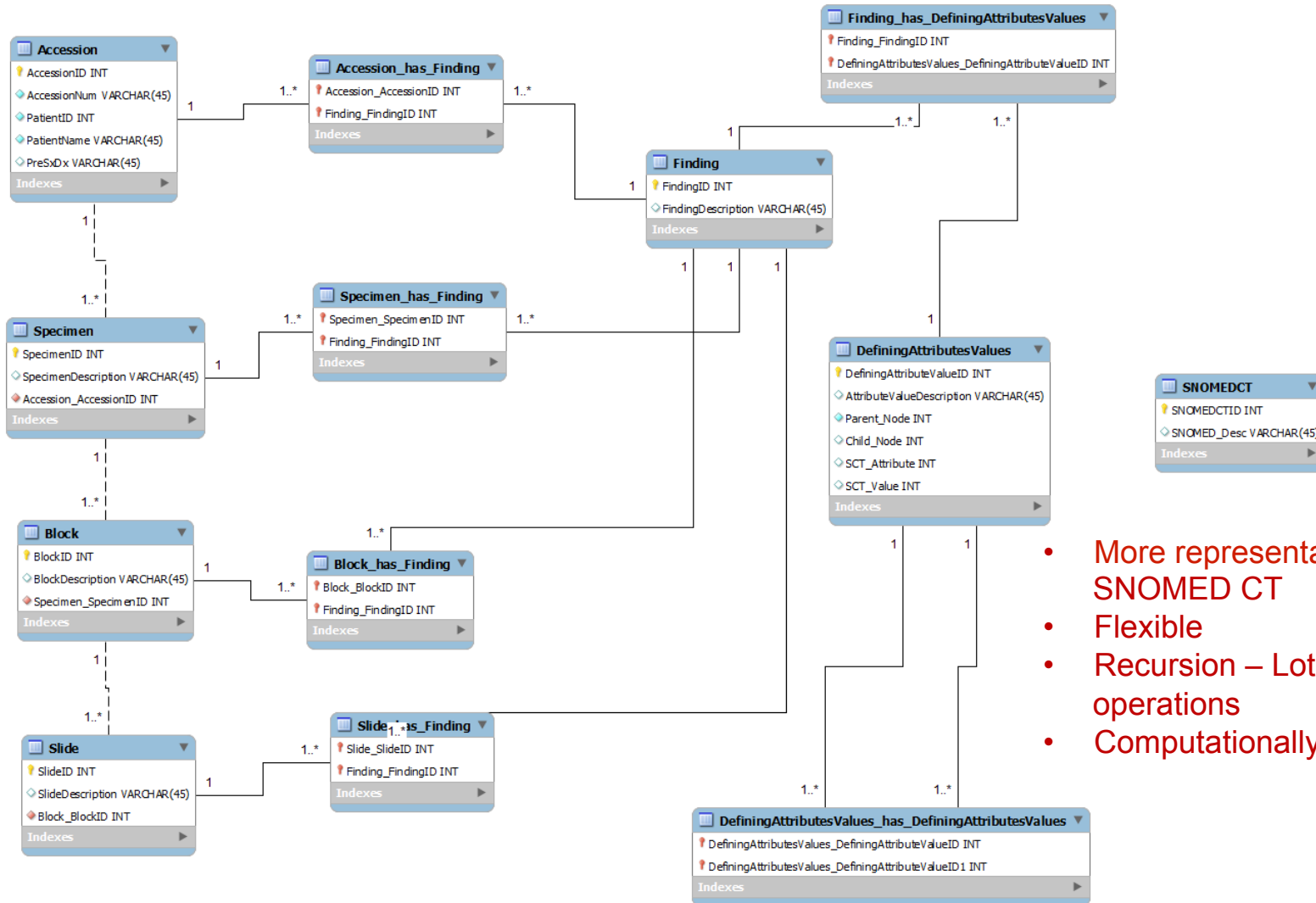
# Expression Table



- **Functional**
- **Requires Terminology Services/Server**
- **Static and not flexible**



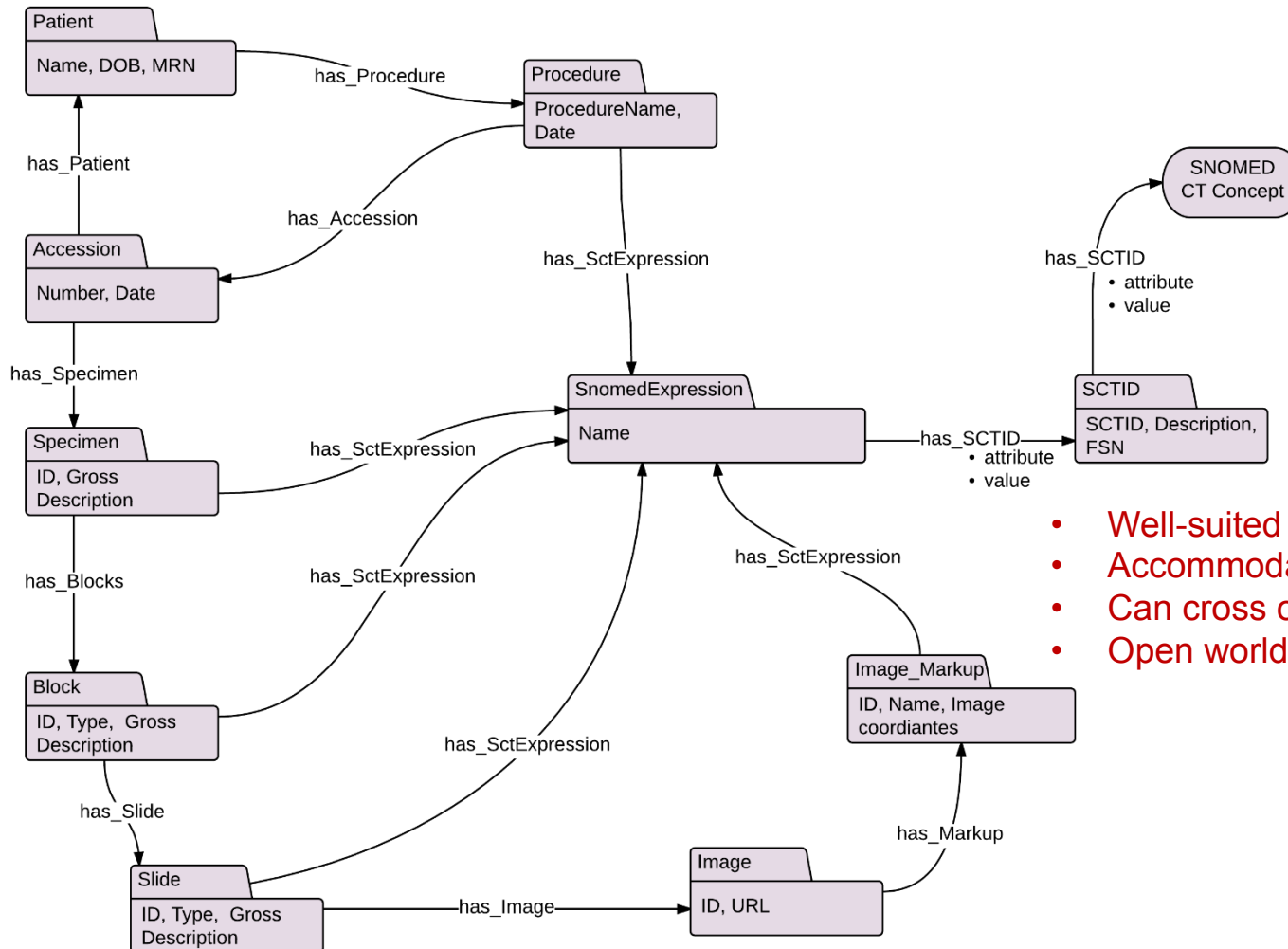
# ER Diagram – Triples?



- More representative of SNOMED CT
- Flexible
- Recursion – Lots of Join operations
- Computationally expensive



# NoSQL – Graph Database



- Well-suited for relationship discovery
- Accommodates ontologies
- Can cross ontologies
- Open world => data targets can be ?





# Future Directions

## Technical:

- Bind WSI modality with structured annotation data structure
- Database insertion
- Report Generation from encoded annotations

## Terminology:

- Increase inventory of clinical utterances
- Observations vs. Clinical Findings
- Concept Definitions
  - Staining Techniques (easy)
  - Architectural Features (more difficult)



# Bibliography

1. Campbell WS, Lele SM, West WW, Lazenby AJ, Smith LM, Hinrichs SH. Concordance between whole-slide imaging and light microscopy for routine surgical pathology. *Hum Pathol*. 2012;43(10):1739-1744.
2. Campbell WS, Hinrichs SH, Lele SM, et al. Whole slide imaging diagnostic concordance with light microscopy for breast needle biopsies. *Hum Pathol*. 2014.
3. Daniel C, Garcia Rojo M, Bourquard K, et al. Standards to support information systems integration in anatomic pathology. *Arch Pathol Lab Med*. 2009;133(11):1841-1849.
4. Garcia Rojo M, Punys V, Slodkowska J, Schrader T, Daniel C, Blobel B. Digital pathology in europe: Coordinating patient care and research efforts. *Stud Health Technol Inform*. 2009;150:997-1001.
5. Campbell WS, Campbell JR, West WW, McClay JC, Hinrichs SH. Semantic analysis of SNOMED CT for a post-coordinated database of histopathology findings. *J Am Med Inform Assoc*. 2014.
6. Campbell WS, Foster KW, Hinrichs SH. Application of whole slide image markup and annotation for pathologist knowledge capture. *J Pathol Inform*. 2013;4:2-3539.107953. Print 2013.
7. Gao YS, SNOGRAPH. <https://github.com/ysgao/SnoGraph>. Updated 2013.



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Thank you



