Representing Surgeries, Pathology Procedures and Pathology Reports Sections in OMOP

Michael Gurley
m-gurley@northwestern.edu
Northwestern Applied Research Informatics Group
5/17/2019

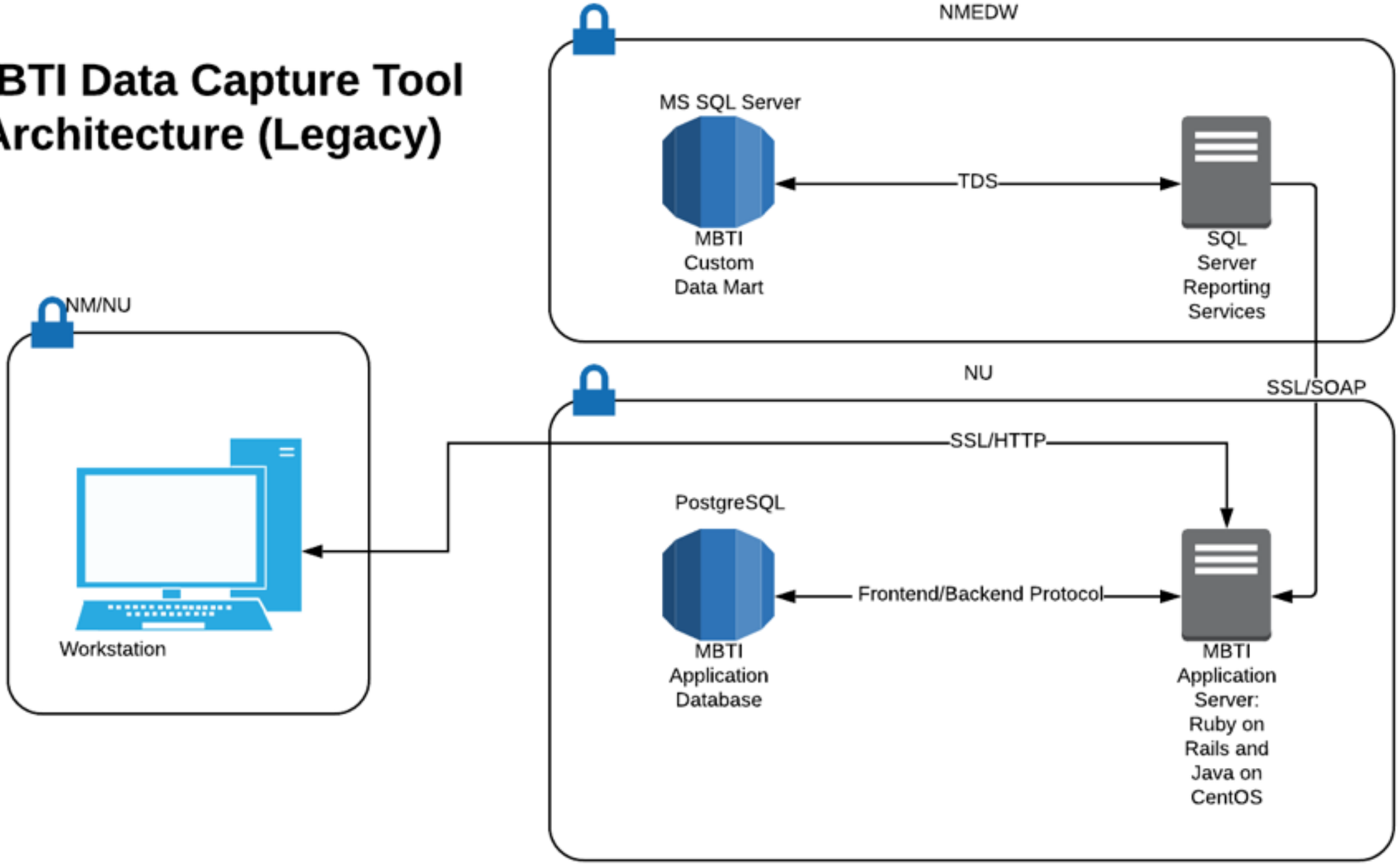
NMEDW:
Daniel Schneider
Prasanth Nannapaneni
Martin Borsje

Northwestern

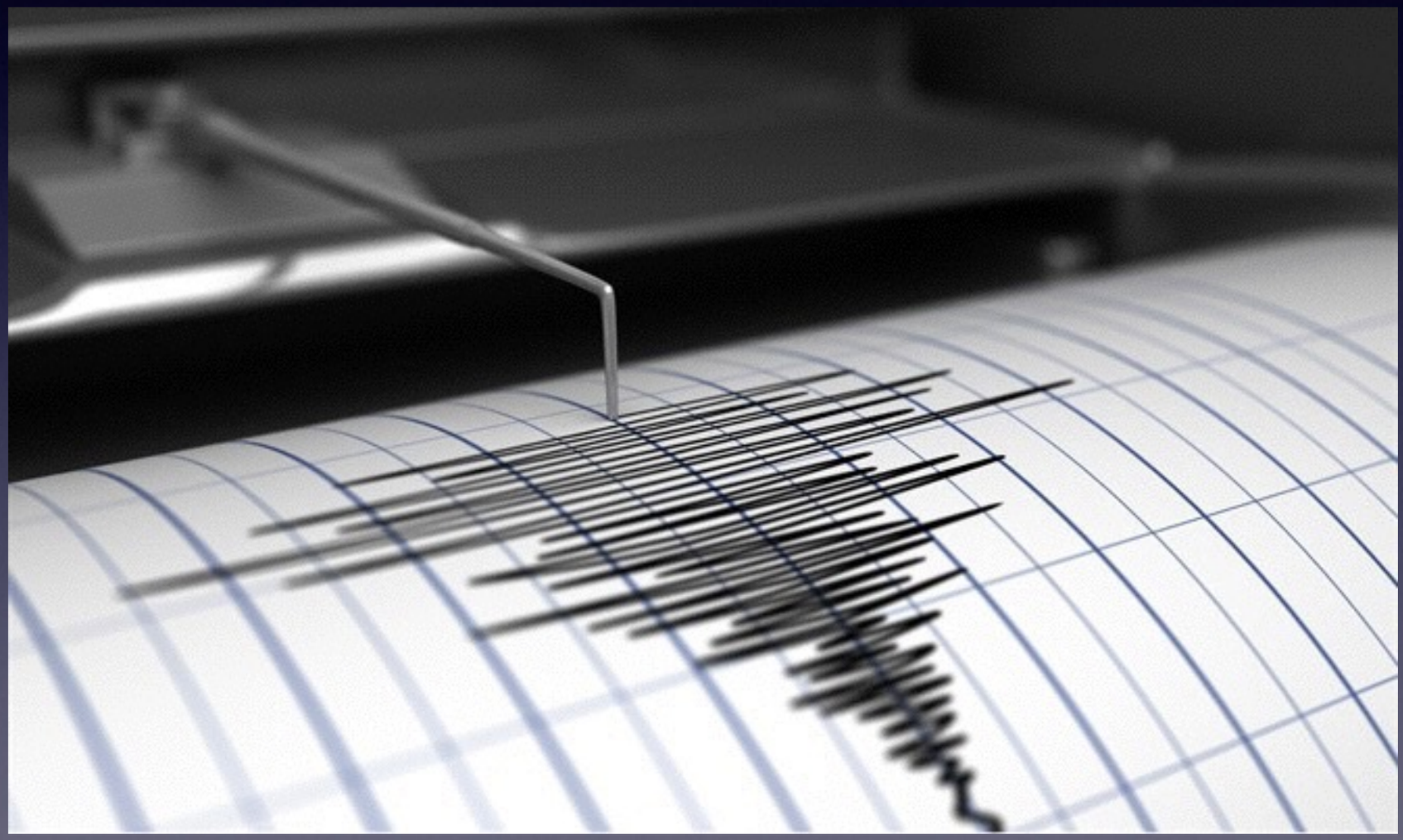
Background:
MBTI Data Capture Tool

- The Northwestern Malnati Brain Tumor Institute outcomes/research database: The MBTI Data Capture Tool (MBTI-DCT).
- Backed by a custom ETL/data mart within the Northwestern Enterprise Data Warehouse (NMEDW) (Microsoft SQL Server and SQL Server Integration Services).
- Aggregates data from Northwestern Medicine's (NM) clinical systems: Epic (Outpatient), Cerner (Inpatient, Surgery, Pathology, Radiology) and MOSAIQ (Radiation Oncology).
- Custom data model.
- Incremental loads of the custom ETL/data mart into a PostgreSQL database via SQL Server Reporting Services (SSRS) exposed as SOAP Web Services.
- The MBTI-DCT includes an NLP-aided chart abstraction user interface for the curation of non-discrete data points from clinical narratives:
    - Anatomic site/histology, WHO grade, recurrence status, pathology findings from pathology reports.
    - Extent of Resection from surgical procedure reports.
    - Anatomical target of radiotherapy from radiation oncology summaries.
    - Performance status declarations, outside treatments from clinic progress notes.
    - Recurrence/progression declarations from imaging exam reports.
- Ruby on Rails user interface. Custom NLP pipeline using the Stanford NLP Java Library and Lingscope.

MBTI Data Capture Tool Architecture (Legacy)



Data Earthquake



Change Happens

- NM merged with other hospital(s).
- Large project to migrate three Epic instances into one instance.
- NM migrated from using Cerner Surginet for tracking surgeries to Epic.
- NMEDW deprecated legacy traditionally modeled “Integrated Data Structures” to new fact/dimension modeled “Integrated Data Structures”.
- Programatic access to SSRS reports via SOAP services was disabled.

Remediation Choice

- All this change broke the MBTI-DCT.
- The custom ETL/data mart's flow of new data stopped because of reliance on deprecated structures and data access strategies.
- Decision:
    - Remediate the ETL's population of the custom data model.

      OR

    - Replace the custom data model with a common data model (CDM) and remediate the MBTI-DCT UI and application logic to work with a CDM.
- All of Us and eMerge CDM activities were ramping up around this time. Laying the ground work for NM investing in transforming its NMEDW into the OMOP CDM.

Choose OMOP: Challenges

- We decided to remediate the MBTI-DCT UI and application logic to work with the OMOP CDM.
- Challenges:
    - Representing PHI.
    - Include all surgeries in the OMOP instance.
    - Include all pathology procedures in the OMOP instance.
    - Include all pathology reports sections in the OMOP instance.
    - Preserve and represent references between surgeries, pathology procedures and pathology report sections.
    - De-duping surgeries and pathology procedures.
    - Work with a truncate/reload data refresh model. Our abstraction/NLP output/curation tables need stable structures to hang off of across data reloads.
    - Remediating MBTI-DCT UI to work with the OMOP CDM.

Challenge:
PHI

- The MBTI-DCT displays PHI. The display of PHI within the MBTI-DCT is necessary to meet curation and outcomes use cases.

- Solution: adopted and reused the PHI table specified and populated for the All of Us project.
  - pii_address
  - pii_email
  - pii_mrn
  - pii_name
  - pii_phone_number

Challenge:
Include all surgeries

- Validate that surgeries were ***not*** being included in the current OMOP build.
- Surgeries at NM are tracked in the new consolidated Epic instance.
- For Epic, the current OMOP build was populating the PROCEDURE_OCCURRENCE table exclusively from charge-oriented tables
    - HSP_ACCT_PX_LIST
    - HSP_ACCT_CPT_CODES
    - HSP_TRANSACTIONS
    - ARPB_TRANSACTIONS
- Asked the NEMEDW OMOP data architect team to pull from actual Epic surgery tables.
    - or_log
    - or_log_all_proc
    - or_proc
    - or_proc_cpt_id
- Automatic mapping to Procedure domain standardized vocabulary entries was achieved by using the or_proc_cpt_id.real_cpt_code field.

Opinion Sidebar:
Prefer Small (accurate) Data
over
Big (messy) Data

- Simple Determinism is better than Clever Probabilism.
  - If a source system represents a class of clinical events in a discrete manner to support a clinical workflow (like Epic does for surgeries), prefer this canonical representation to the clinical event welter caused by charge-oriented representations.
- Open question:
  - Exclude charge-related representations?


YEAH, WELL, YOU KNOW,
THAT'S JUST, LIKE,
YOUR OPINION, MAN.
imgflip.com

Challenge:
Include all pathology procedures

- Validate that pathology procedures were ***not*** being included in the current OMOP build.
- Pathology procedures at NM are tracked in Cerner Pathnet Anatomic Pathology.
- For Cerner, the current OMOP build was populating the PROCEDURE_OCCURRENCE table from charge-oriented tables
    - encounter (from Cerner)
    - EPSI charge tables
- Asked the NEMEDW OMOP data architect team to pull from actual Cerner Pathnet Anatomic Pathology tables.
    - pathology_case
    - prefix_group
    - case_specimen
    - case_report
    - clinical_event
    - ce_blob
- Made mappings from local prefix_group entries to standardized Procedure domain entries in the SNOMED vocabulary. Mostly along this axis: Procedure | Labratory Procedure (procedure) | Anatomic Pathology Procedure. See spreadsheet.
- Need to to map local Cerner case_specimen specimen codes to the Specimen domain entries in the SNOMED vocabulary.

Challenge:
Include all pathology reports sections in the OMOP instance.

- Validate that pathology reports sections were being included in the current OMOP build ***as separate entries in the NOTE table with the section name populating the note_title field.***
- Pathology reports sections at NM are tracked in Cerner Pathnet Anatomic Pathology.
- Pathology reports are written in ‘sections’. Each section having a dedicated purpose. For example: ‘Final Diagnosis’,’Microscopic Description’, ‘Specimen/Gross Description’ and ‘Clinical Information’.
- Most often the data points desired to be extracted from a pathology report reside in the ‘Final Diagnosis’ section.
- Other ‘sections’ can often be the source of false positives for NLP pipelines. For example, historical diagnoses mentioned in the ‘Clinical Information’ section.
- Simple Determinism is better than Clever NLP.
    - If a source system splits a pathology reports into discrete labeled sections to support a clinical workflow (like Cerner does for pathology reports), prefer this canonical representation instead of a multi-section conglomerated representation.
- Don’t use the sectionizing component of your NLP pipeline if your source system sectionizes for you.

Challenge:
Preserve and represent references between surgeries, pathology procedures and pathology report sections.

- Validate that references between surgeries, pathology procedures and pathology report sections were ***NOT*** being included in the current OMOP build.
- The conventional advice to tie OMOP clinical events by joining to VISIT_OCCURRENCE ***is insufficient***.
    - Possible for one VISIT_OCCURRENCE to span multiple surgery entries and multiple pathology procedures in PROCEDURE_OCCURRENCE.
    - Possible for one VISIT_OCCURRENCE entry to span multiple pathology reports.
- Make explicit references between surgical PROCEDURE_OCCURRENCE entires and pathology PROCEDURE_OCCURRENCE entires via FACT_RELATIONSHIP.
    - Asked the NEMEDW OMOP data architect team to build a join table within the NMEDW integrated data structures associating Cerner pathology procedures and Epic surgeries. Match on patient and surgery date to pathology accession date/case collection date. ETL the join table into the OMOP FACT_RELATIONSHIP table
- Make explicit references between pathology report section NOTE entires and pathology PROCEDURE_OCCURRENCE entires via FACT_RELATIONSHIP (we are not on OMOP CDM version yet where this can be done directly within the NOTE table with note_event_id and note_event_field_concept_id).
    - Asked the NMEDW OMOP data architect team to build a join table within the NMEDW integrated data structures associating Cerner pathology procedures and Cerner pathology report sections. ETL the join table into the OMOP FACT_RELATIONSHIP table

```
SELECT note.note_id
     , note.note_date
     , note_stable_identifier.id
     , note_stable_identifier.stable_identifier_path
     , note_stable_identifier.stable_identifier_value
     , note.note_title
     , note.note_text
     , procedure_occurrence.procedure_occurrence_id
     , procedure_occurrence.procedure_concept_id
     , concept.concept_code
     , procedure_occurrence.procedure_date
     , procedure_occurrence_stable_identifier.id
     , procedure_occurrence_stable_identifier.stable_identifier_path
     , procedure_occurrence_stable_identifier.stable_identifier_value_1
     , prov1.provider_name
     , prov2.provider_name
     , posi2.id
     , posi2.stable_identifier_path
     , posi2.stable_identifier_value_1
FROM note_stable_identifier JOIN note                                    ON stable_identifier_value_1.note_id = note.note_id
                            JOIN fact_relationship                       ON fact_relationship.domain_concept_id_1 = 5085 AND fact_relationship.fact_id_1 = note.note_id AND fact_relationship.relationship_concept_id = 44818790
                            JOIN procedure_occurrence                    ON fact_relationship.domain_concept_id_2 = 10 AND fact_relationship.fact_id_2 = procedure_occurrence.procedure_occurrence_id AND procedure_occurrence.procedure_concept_id = 4213297
                            JOIN procedure_occurrence_stable_identifier  ON procedure_occurrence.procedure_occurrence_id = procedure_occurrence_stable_identifier.procedure_occurrence_id
                            JOIN concept                                 ON procedure_occurrence.procedure_concept_id = concept.concept_id
                            JOIN fact_relationship AS fr2                ON fr2.domain_concept_id_1 = 10 AND fr2.fact_id_1 = procedure_occurrence.procedure_occurrence_id AND fr2.relationship_concept_id = 44818888
                            JOIN procedure_occurrence pr2                ON fr2.domain_concept_id_2 = 10 AND fr2.fact_id_2 = pr2.procedure_occurrence_id
                            JOIN procedure_occurrence_stable_identifier posi2 ON pr2.procedure_occurrence_id = posi2.procedure_occurrence_id
                            JOIN provider prov1                          ON procedure_occurrence.provider_id = prov1.provider_id
                            JOIN provider prov2                          ON pr2.provider_id = prov2.provider_id
WHERE note.note_title = 'Final Diagnosis'
```

FACT_RELATIONSHIP

- Entry between pathology report section in NOTE and pathology procedure in PROCEDURE_OCCURRENCE: relationship_concept_id = 44818790 ‘Has procedure context (SNOMED).’ Plus converse entry.

- Entry between pathology procedure in PROCEDURE_OCCURRENCE and surgery in PROCEDURE_OCCURRENCE: relationship_concept_id = 44818888 ‘Procedure context of (SNOMED)’ Plus converse entry.

Challenge:
De-duping surgeries and pathology procedures

- Entries in FACT_RELATIONSHIP allow us to surface these clinical events from the morass of charge-related representations for the same clinical events. Enabling de-duplication.

- Would be nice if OMOP natively contained some kind of way of designating entries in the PROCEDURE_OCCURRENCE table as canonical or first-class versus entries that are financial echoes of the same clinical events

Challenge:
Work with a truncate/reload data refresh model.

- New load strategy:
    - Replacement of programmatic access to data via SSRS.
    - NMEDW has a single OMOP instance that is partitioned during extraction by a cohort definition for the MBTI.
    - The NMEDW extract framework deposits files on a shared folder mounted to the MBTI-DCT application server.
        - Incremental loads not feasible.
- Stable Identifiers
    - OMOP internal IDs change across truncate/reload data refreshes.
    - Our abstraction/NLP output/curation tables need stable structures to hang off of across data reloads.
    - Asked the NEMEDW OMOP data architect team to populate stable identifier tables for NOTE and PROCEDURE_OCCURRENCE.
    - The stable identifier tables contains an invariant ‘id’ column that stays stable across loads, an OMOP internal id column (‘note_id’, ‘procedure_occurrence_id’) that changes across loads and invariant pointers to source-system row-level provenance via the ‘stable_identifier_path’ and ‘stable_identifier_value’ columns.

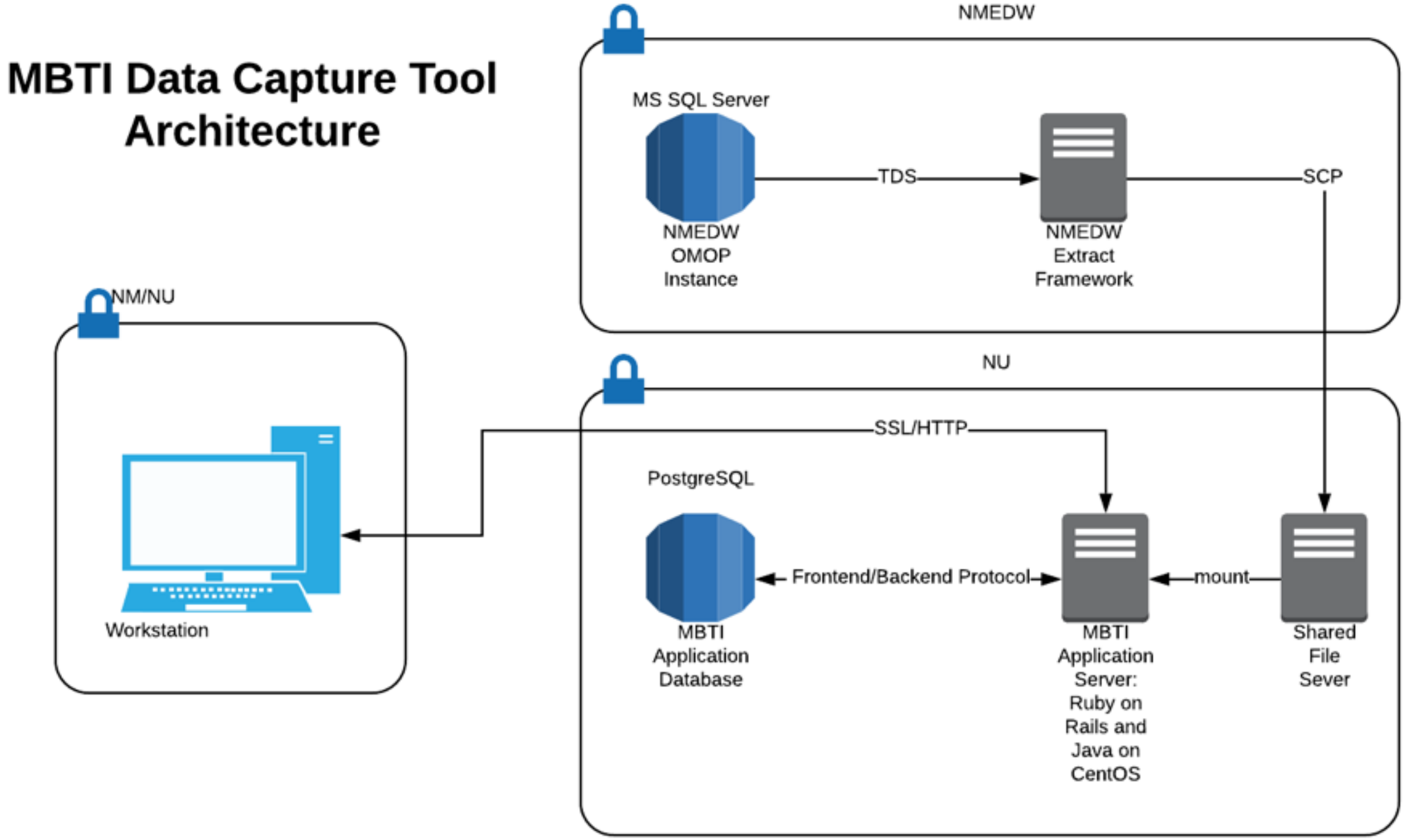
NOTE_STABLE_IDENTIFIER

```
CREATE TABLE public.note_stable_identifier
(
  id bigint NOT NULL DEFAULT nextval('note_stable_identifier_id_seq'::regclass),
  note_id bigint NOT NULL,
  stable_identifier_path character varying NOT NULL,
  stable_identifier_value character varying NOT NULL,
  CONSTRAINT note_stable_identifier_pkey PRIMARY KEY (id)
)
```

PROCEDURE_OCCURRENCE_STABLE_IDENTIFIER

```
CREATE TABLE public.procedure_occurrence_stable_identifier
(
  id bigint NOT NULL DEFAULT
nextval('procedure_occurrence_stable_identifier_id_seq'::regclass),
  procedure_occurrence_id bigint NOT NULL,
  stable_identifier_path character varying NOT NULL,
  stable_identifier_value_1 character varying NOT NULL,
  stable_identifier_value_2 character varying,
  stable_identifier_value_3 character varying,
  stable_identifier_value_4 character varying,
  stable_identifier_value_5 character varying,
  stable_identifier_value_6 character varying,
  CONSTRAINT procedure_occurrence_stable_identifier_pkey PRIMARY KEY (id)
)
```

MBTI Data Capture Tool Architecture



Challenge:
Remediating MBTI-DCT UI
to work with the OMOP CDM
Index Page

- Legacy MBTI-DCT UI was based on a custom data model. Each type of note targeted for NLP-aided chart abstraction had its own dedicated table: pathology reports, imaging exam reports, clinic progress notes and radiation oncology summaries. Each note type had its own dedicated index and edit page.

- Index Page

  - Remediate one index screen to display notes needing curation by abstraction ‘namespaces’. A ‘namespace’ ties an event cohort defined by search criteria (for example, a ‘Surgical Pathology’ napesapce that binds to all ‘Final Diagnosis Section’ notes related to ‘Surgical pathology procedure’ procedure occurrences) to a set of NLP-suggestible/abstractable/curatable data points (‘Site’, ‘Histology’, ‘WHO Grade’, ‘IDH1 Status’, ‘p53).

  - Remediate the index screen to allow for searching:

    - By keyword search across OMOP PHI tables and the note text.

    - By note date.

    - By providers associated with a first level procedures (for example, pathology procedures) and second level procedures (for example, surgeries).

Challenge:
Remediating MBTI-DCT UI
to work with the OMOP CDM
Edit Page

- Edit Page
  - Remediate the edit screen to display data from the OMOP PHI tables.
  - Remediate the edit screen to display the list of abstractable data points for a note based on the set of abstractable data points bound to a ‘namespace’.
  - Remediate the edit screen to display associated first level and second level procedures.
  - Remediate the edit screen to display other note entries associated to first level procedures (for example, all other “sections” of the current pathology report section)

MBTI | Notes

0.0.0.0:3000/notes?utf8=✓&abstraction_status=needs+review&namespace_id=19&search=&de

Search

Northwestern MBTI Data Capture Tool

Notes

Reviewed?

needs review

Namespace

- Molecular Pathology
- Surgical Pathology
- Outside Surgical Pathology

Search

From

To

Provider

× HORBINSKI, CRAIG

SEARCH Clear

1 2 3 4 5 6 7 8 9 10 11 12

Note Date	Note Type	Note Title	First Name	Last Name	MRN(s)	
01/01/1900	Note	Final Diagnosis	Bob	Jones	**Northwestern** 000000000	Review
01/01/1900	Note	Final Diagnosis	Bob	Jones	**Northwestern** 000000000	Review
01/01/1900	Note	Final Diagnosis	Bob	Jones	**Northwestern** 000000000	Review
01/01/1900	Note	Final Diagnosis	Bob	Jones	**Northwestern** 000000000	Review

Note

Back | Notes | Previous | Next

Patient	MRN(s):	Note Date	Note Type	Note Class	Title	Provider
Bob N Jones	**Northwestern** 000000000	01/01/1900	Note	No matching concept	Final Diagnosis	

Procedures

Procedure	Date	Provider	Specimens	Notes	
Surgical pathology procedure	01/01/1900	HORBINSKI, CRAIG M.		Specimen/Gross Description	VIEW
				Intraprocedural Consultation Findings	VIEW
				Clinical Information	VIEW
				Surg Path Non-Chartable Comment	VIEW
				Addendum	VIEW
Craniectomy, trephination, bone flap craniotomy; for excision of meningioma, supratentorial	01/01/1900	CHANDLER, JAMES P.			

NOT APPLICABLE ALL | UNKNOWN ALL

Note text

NOT APPLICABLE ALL | UNKNOWN ALL

Metastatic Cancer

Histology

- [x] adenocarcinoma, metastatic (8140/6)
- [ ] not applicable
- [ ] unknown

Edit | CLEAR

Site

- [ ] cerebellum, nos (c71.6)
- [ ] not applicable
- [ ] unknown

Edit | CLEAR

Primary Site

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

Laterality

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

Recurrent

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

NOT APPLICABLE GROUP | UNKNOWN GROUP

ADD METASTATIC CANCER

Note text

A and B. Tumor, cerebellum, resection:
Metastatic adenocarcinoma (see Note).

Note: This tumor shows tall columnar cells with lumenal necrosis, the combination of which is a classic hallmark of colorectal adenocarcinoma.

IDH1 Status

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

IDH2 Status

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

1P Status

- ○ deleted ○ non-deleted

SAVE Cancel

19q Status

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

10q/PTEN Status

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

MGMT promoter methylation status Status

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

ki67

- [ ] not applicable
- [ ] unknown

Edit | CLEAR

p53

- [ ] not applicable
- [ ] unknown

Note text

A and B. Tumor, cerebellum, resection:
Metastatic adenocarcinoma (see Note).

Note: This tumor shows tall columnar cells with lumenal necrosis, the combination of which is a classic hallmark of colorectal adenocarcinoma.

Future

- Change and Challenges:
    - Need to incorporate into our OMOP instance legacy surgeries from Cerner Surginet.
    - Need to incorporate into our OMOP instance pathology procedures from a Cerner Co-Path instance to be loaded into our NMEDW.
    - Need to incorporate into our OMOP instance pathology procedures from a pending migration to Epic Beacon.
    - Improving our NLP algorithms. Not an NLP programmer. NLP pipeline has a RESTful interface that can delegate the generation of suggestions for a document and namespace to an endpoint and receive back suggestions via a endpoint. So better NLP can be used.
    - Opensource the user interface and NLP pipeline as “OMOP Abstractor”.

Thanks!