JSS Raxa Lab Data Model

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person_attribute_type
- person_attribute_type_id INT(11)

person_identifier_type
- person_identifier_type_id INT(11)

person_attribute
- person_attribute_id INT
- person_id INT
- person_attribute_type_id INT

concept_name
- concept_name_id INT
- concept_id INT
- concept_name VARCHAR(45)

concept_set
- concept_set_id INT
- concept_id INT
- concept_set INT
- sort_weight DOUBLE

person_identifier
- person_identifier_id INT
- person_id INT(11)
- person_identifier_type_id INT

person
- person_id INT(11)

concept
- concept_id INT
- concept_class INT

concept_class
- concept_class_id INT

location
- location_id INT

patient
- patient_id INT

provider
- provider_id INT

encounter
- encounter_id INT
- location_id INT
- patient_id INT
- provider_id INT

order
- order_id INT
- order_type_id INT
- concept_id INT
- orderer INT
- encounter_id INT
- instructions VARCHAR(255)
- start_date TIMESTAMP
- autoexpire_date TIMESTAMP
- discontinued BOOLEAN
- discontinued_date TIMESTAMP
- discontinued_by INT
- discontinued_reason VARCHAR(255)
- patient_id INT
- accession_number VARCHAR(255)

order_type
- order_type_id INT
- name VARCHAR(255)
- description VARCHAR(255)

obs
- obs_id INT
- order_id INT
- concept_id INT
- encounter_id INT
- patient_id INT

jsslab_precondition
- precondition_id INT
- test_panel_id INT
- precondition_question_concept INT
- precondition_answer_concept INT
- sort_order DOUBLE

jsslab_test_panel
- test_panel_id INT
- lab_location_id INT
- test_group_concept INT
- test_panel_concept INT
- test_panel_code VARCHAR(5)
- received_specimen_type_concept INT
- analysis_specimen_type_concept INT
- cost DECIMAL
- turnaround DOUBLE
- hold_time DOUBLE

jsslab_test
- test_id INT
- test_panel_id INT
- test_concept INT
- result_format VARCHAR(24)
- sort_order DOUBLE
- confirm_test_id INT

jsslab_test_range
- test_range_id INT
- test_id INT
- sort_order DOUBLE
- range_sex CHAR(1)
- range_age_min DOUBLE
- range_age_max DOUBLE
- range_attribute_type INT
- range_attribute_value VARCHAR(45)
- range_normal_low DOUBLE
- range_normal_high DOUBLE
- range_critical_low DOUBLE
- range_critical_high DOUBLE

jsslab_report
- report_id INT
- lab_report_id VARCHAR(12)
- report_status_concept INT
- approved_by INT
- approved_date TIMESTAMP
- comments VARCHAR(255)
- result_delivery_date TIMESTAMP
- result_delivery_concept INT

jsslab_specimen
- specimen_id INT
- lab_specimen_id VARCHAR(45)
- client_specimen_id VARCHAR(45)
- ordered_by INT
- person_id INT
- patient_id INT
- specimen_date TIMESTAMP
- received_date TIMESTAMP
- received_condition_concept INT
- received_specimen_type_concept INT
- report_id INT
- result_requested_by TIMESTAMP
- hidden BOOLEAN

jsslab_test_specimen
- test_specimen_id INT
- specimen_id INT
- specimen_sub_id VARCHAR(5)
- parent_sub_id VARCHAR(5)
- parent_relation_concept INT
- analysis_specimen_type_concept INT
- test_panel_id INT
- test_role_concept INT
- supply_item_id INT
- lab_tech_id INT
- test_date DATETIME
- test_run_id INT
- well_position VARCHAR(5)

jsslab_test_result
- test_result_id INT
- test_result_id INT
- test_result_type INT
- test_answer_concept INT
- test_answer_duration DOUBLE
- test_answer_titer INT
- test_answer_numeric DOUBLE
- test_answer_string VARCHAR(255)
- test_answer_flag VARCHAR(5)
- test_answer_note VARCHAR(45)
- test_normal_low DOUBLE
- test_normal_high DOUBLE
- test_critical_low DOUBLE
- test_critical_high DOUBLE
- approved BOOLEAN
- approved_by INT
- hidden BOOLEAN

test
- test_id INT
- order_id INT
- ordered_by INT
- test_set INT
- test_complete_date TIMESTAMP
- test_released_date TIMESTAMP
- test_rejected BOOLEAN
- test_rejected_by INT
- test_rejected_reason VARCHAR(255)
- test_comment VARCHAR(255)

jsslab_test_run
- test_run_id INT
- instrument_id INT
- lab_tech_id INT
- run_start TIMESTAMP
- run_end TIMESTAMP

jsslab_instrument
- instrument_id INT
- property_tag VARCHAR(45)
- manufacturer VARCHAR(45)
- model VARCHAR(45)
- received_date DATE
- received_from VARCHAR(45)
- received_cost DECIMAL
- received_value DECIMAL
- condition_date DATE
- condition_concept_id INT
- maintenance_vendor VARCHAR(45)
- maintenance_phone VARCHAR(45)
- maintenance_description VARCHAR(225)

jsslab_supply_item
- supply_item_id INT
- stock_number VARCHAR(45)
- manufacturer VARCHAR(45)
- manufacturer_order_id VARCHAR(45)
- item_name VARCHAR(45)
- item_class_concept INT
- lot_number VARCHAR(45)
- expiration_date TIMESTAMP

jsslab_inst_maint
- inst_maint_id INT
- instrument_id INT
- maint_date DATE
- maint_by VARCHAR(45)
- maint_scheduled BOOLEAN
- maint_performed VARCHAR(255)

Data Model Domains

- **Standard OpenMRS**
  - Person, patient, etc.
  - Location, provider/user
  - Encounter, observation
  - Concept, etc.
  - Order, etc.
  - Logic expression
- **Ordering & Collection**
  - Test Panel
  - Test
  - Specimen Template
  - Precondition
  - Lab Order, Order Specimen

- **Processing & Testing**
  - Specimen
  - Test Specimen
  - Test Result
  - Lab Report
  - Test Ranges
  - (Test Run)
- **Management**
  - Periodic Reporting
  - (Supply Item)
  - (Supply Item Xactn)
  - (Instrument)
  - (Instrument Maintenance)

Concepts as Code Tables

Permit internationalization, mapping to standard terminology, storage of HL7 representation

- Specimen type
- Specimen condition
- Specimen role
- Instrument condition
- Question/answer:
  - Preconditions
  - Categorical test results

- Report status
- Report distribution
- Reject reason
- Result flags

Ordering & Collection

Test/Concept Hierarchy
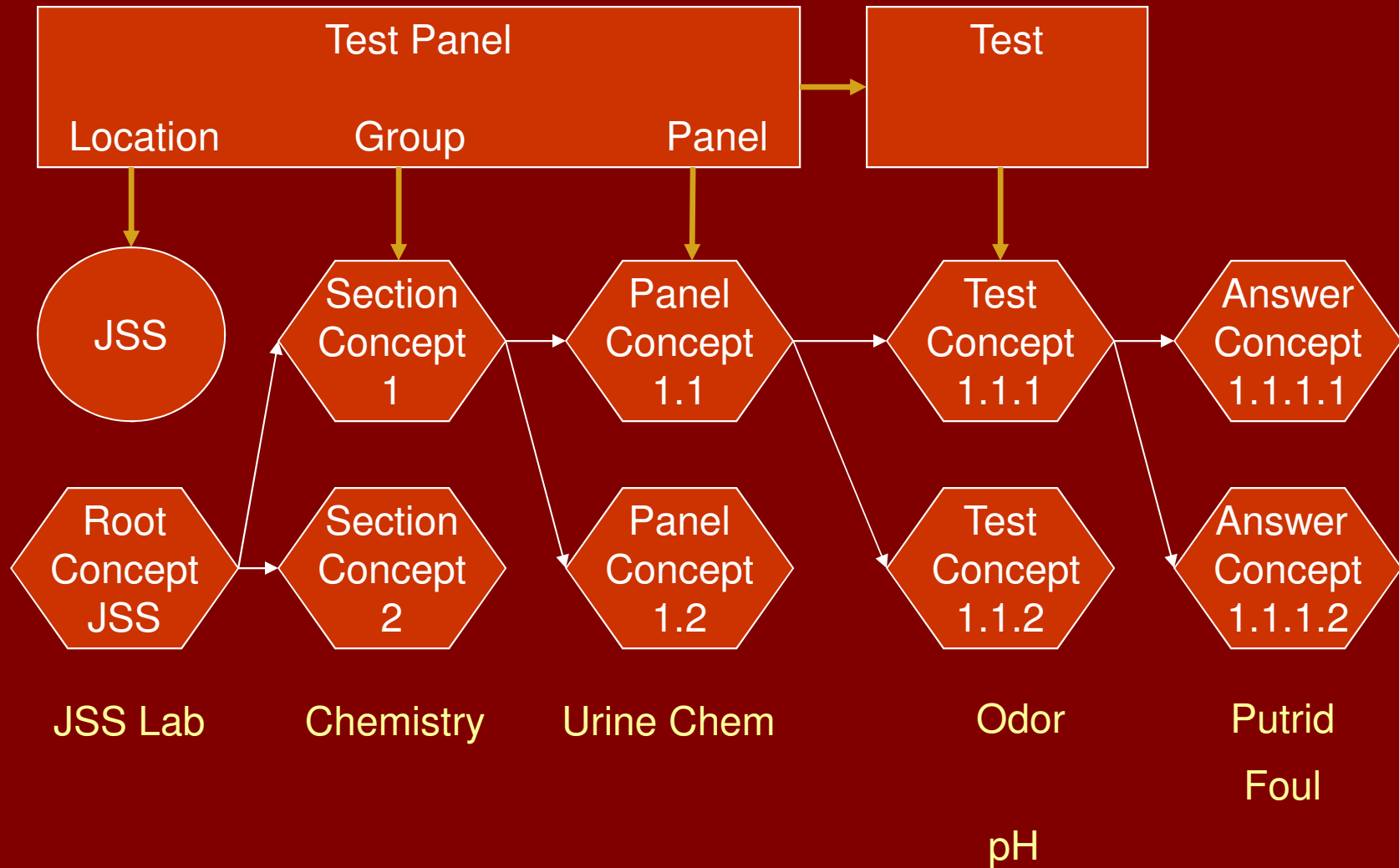
Test/Concept Hierarchy

- Test Panel/Test
  - Multiple labs' offerings distinguished by location
  - Groups determine what tests are logged or counted together
  - Panels offer one or more tests to be performed on a particular specimen type
  - Tests correspond to result names
- Concepts
  - All group/panel/test names are stored as concepts
  - The root concept is linked to group/panel/test
  - Tests with categorical results have answer lists

Ordering Process

- The ordering provider selects or enters a patient
  - A lab order may be found or created
  - A patient/person may be found or created
- The provider uses the Test/Concept hierarchy to choose a panel
- The provider chooses whether the test is urgent
- The system generates a lab order
- The lab order can be viewed and printed

What's Wrong with Orders

- Relation of orders to specimens is m:n
- Relation of orders to test panels is 1:1 but many labs allow orders for multiple tests
- OpenMRS orders lack some information required by lab standards
- OpenMRS order data model will change in version 1.10
- Many JSS lab orders are verbal or implied

Collection Process

- Collector selects or enters orders for patient
  - The order and patient screen are available for checking or entry
- Collector selects orders which are being collected now (e.g. stool might come later)
- System displays precondition questions and answers (should be categorical)
  - Same question may be required for multiple panels but only asked once
- System records specimen collection encounter
- System records answers as observations and indicates which tests can proceed (manual override), giving specimen holder (received specimen type) required

Processing & Testing

Processing & Testing Data Model
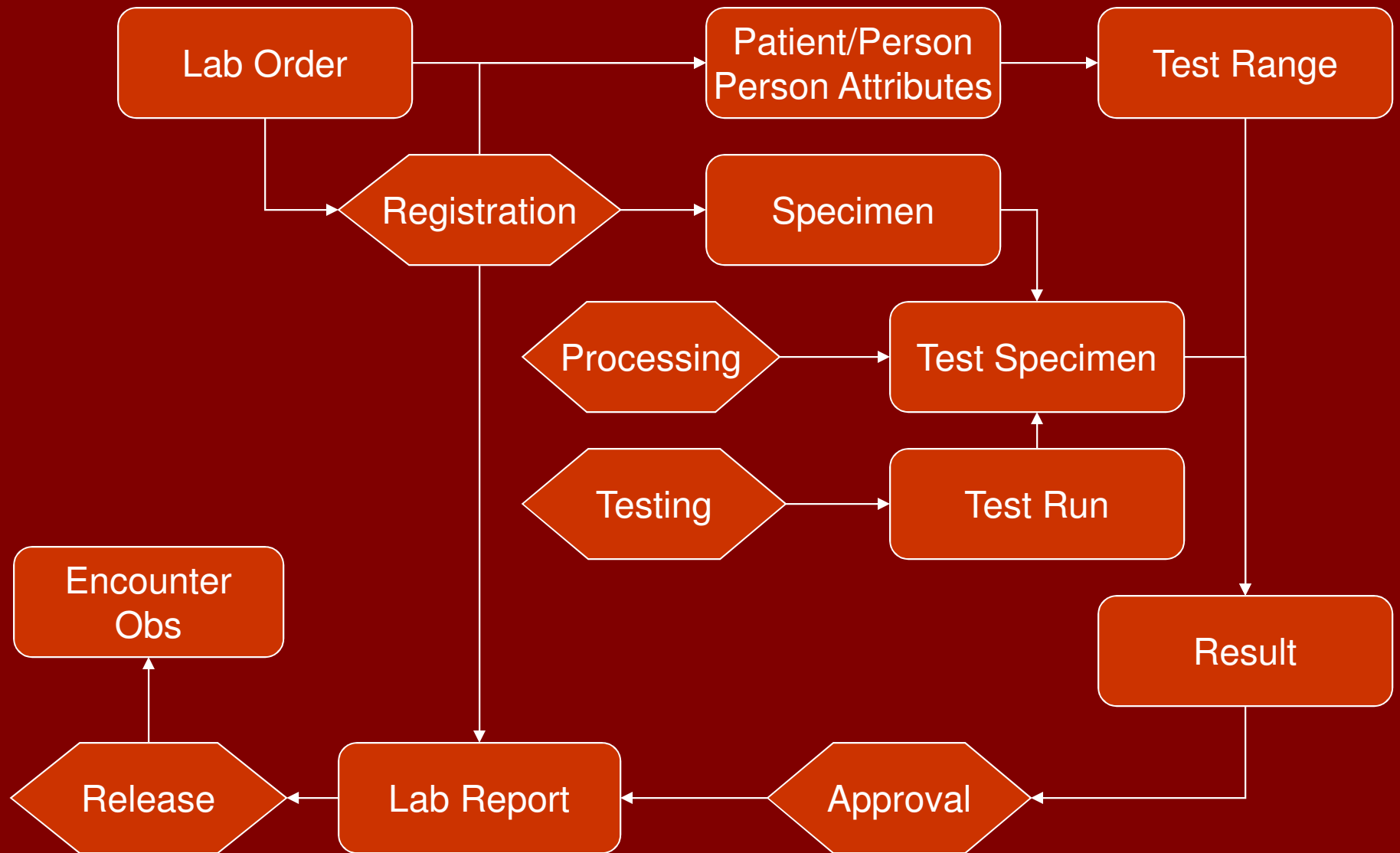
Object Definitions

- Lab order: a request from a provider that one or more specimens be collected from a patient and that a panel of tests be performed on them
- Specimen: what is received at the lab for testing
- Lab Report: what the lab produces; covers all tests for a set of orders and specimens
- Test Specimen: what is prepared from the specimen that actually undergoes testing
- Test Panel: A collection of tests which are ordered together
- Test: Process by which a single result value is assigned to a specific specimen
- Control: a standard specimen tested by the same process as test specimens to serve as a comparison when assigning results
- Test Run: a group of specimens undergoing the same test subject to the same controls

Mapping the Objects to JSS

- Specimens
  - Client Specimen ID is date (implied), patient ID, test code
  - Lab Specimen ID is date (implied), test section, sequence; replace with date, sequence, check digit
- Test specimens
  - Typically distinguished from specimens via numeric suffix
  - Some sections may be using rack position to identify test specimens.
  - Will there be a computer for recording prep step? What is the best process for result entry?
- Test runs
  - Not currently used for most tests; for now, should be one per lab tech per test panel per day, automatically generated
- Lab Reports
  - Currently results written in patient folders or satellite result books
  - Now will be a formal document, can be filed in notebook

Orders in the Data Model
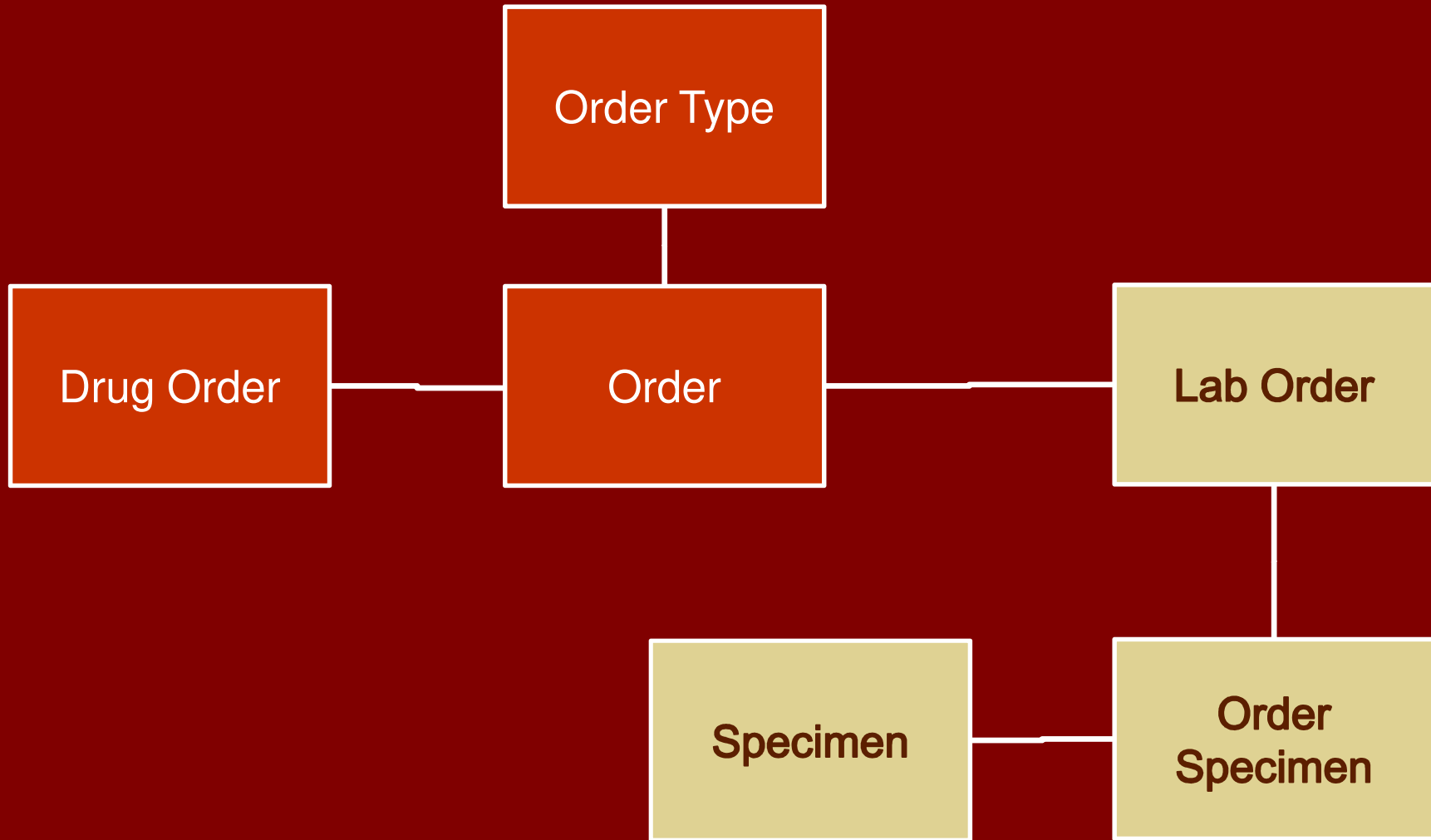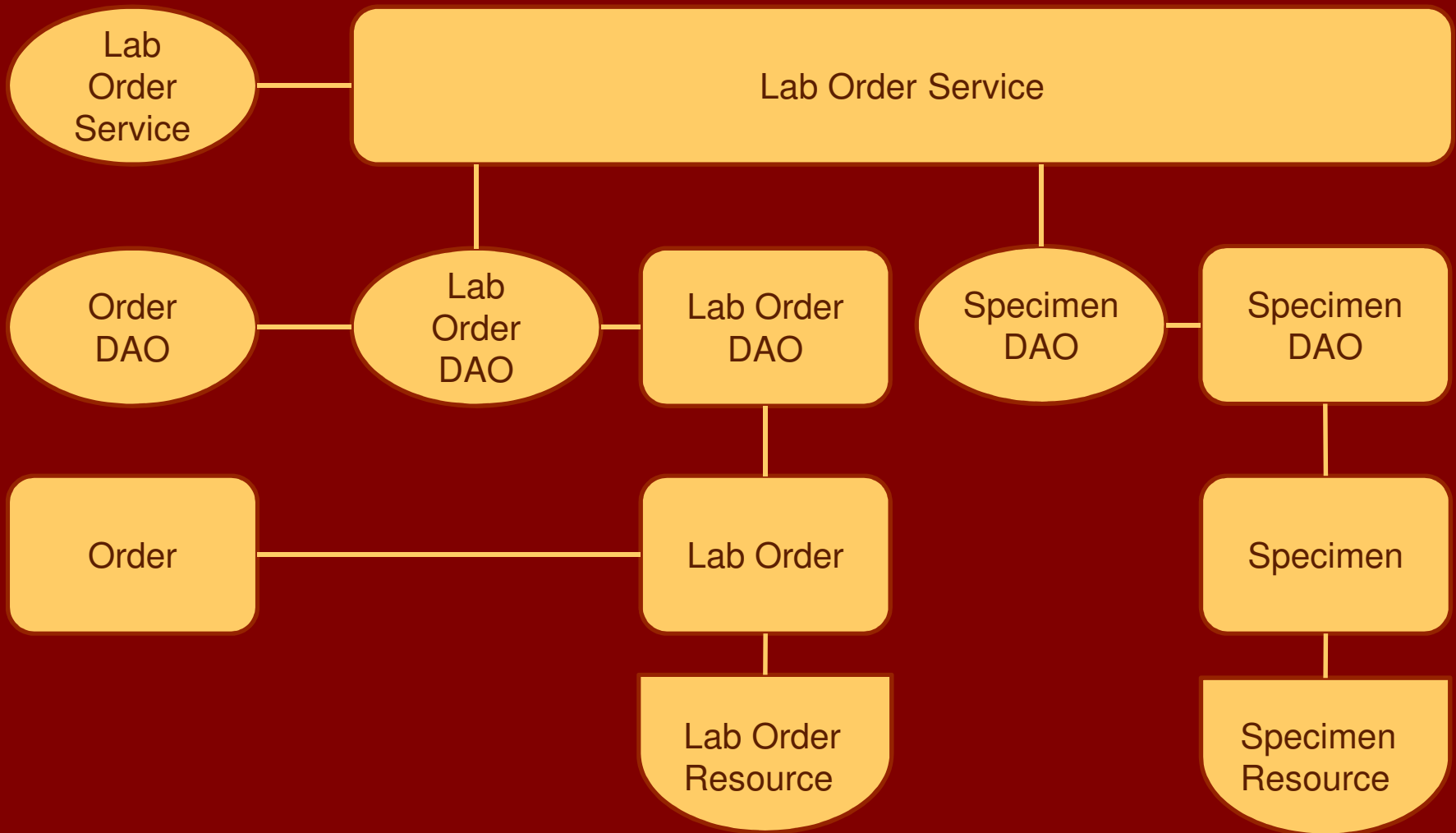
Queues

- Collection Queue
  – Lab order for patient without subsequent collection encounter
- Prep Queue (if prep is recorded)
  – Test specimen without prep date
- Test Queue
  – Test specimen (with prep date) without test date
  – Queued test specimens without a Test Run should be flagged
  – Divided into subqueues based on lab group or lab panel
- Approver Queue
  – Tests with results but without approval
  – Reports without release date with at least one test result
  – Queued reports with all test results should be flagged
- Distribution Queue
  – Reports with release date without delivery date

Registration Process

Replaces individual section registration

- A specimen is received
  - A lab order may be found or created
  - A patient/person may be found or created
- A client specimen ID is entered if available and a lab specimen ID is created
- The type and condition are entered and the system creates the specimen
- The system creates a test specimen for the original specimen and for each panel requested by the user
  - Only panels whose received specimen type is the same as the specimen's specimen type are available for selection.
  - Those test specimens associated with a specimen whose specimen type is not the analysis specimen type of the panel need to be created by processing
  - Test specimens can also be created manually by selecting a test specimen as a source and specifying the type of the new test specimen
- The system assigns a lab report
  - All specimens for the same patient ordered by the same provider are assigned to any existing report with no results
  - A specimen may be moved between reports or to a new report if the automatic assignment is not appropriate
  - Lab orders are assigned automatically to the reports of their patient; they can be created and assigned manually if needed (e.g. late arriving stool sample)

When/Where Processes Occur

	Patients from OPD, screener	Specimens from IPD, OT, etc.	Specimens from satellite clinics
Enter Lab Order	OPD or Specimen Collection	Source or Specimen Registration	Specimen Registration (future remote entry)
Collect Specimen	Specimen Collection	Source	Source
Register Specimen	Specimen Collection	Specimen Registration	Specimen Registration

Specimen collection personnel can register specimens
from other sources if workload so requires

Specimen Processing Process

Many labs batch this process by test panel

- Processing transforms a specimen from one type to another suitable for testing
- If processing is being tracked
  - The processor selects the test specimen
  - The system updates the test specimen with the time and person who processed it
  - If rack position is being used, that can be entered

Testing Process

Many labs batch this process by test panel; some panels require batching

- The lab tech selects one or more test specimens for testing
  - The system assigns the specimens to the open test run for that panel (manual override)
- The lab tech performs the test and enters the result
- The system determines the test ranges and updates the result

Determining Test Ranges

- Tests can have zero or more rows of test ranges
  - Tests with no rows do not have ranges (categorical)
  - Rows are evaluated in user-specified order
- Each row can contain sex, minimum age, maximum age, and the name of a logic expression
  - The first row which matches the patient on all four criteria are met (logic expression evaluates true)
  - Criteria which are not specified in a row are considered a match (a row with no criteria is always a match)
- The selected row's range boundaries are used

Approval Process

- A lab report is selected
- The system displays each test result and comment
  - Results may be approved or rejected
  - Results and comments may be hidden
- The system can display quality information
  - For a result's test, it can display a histogram for run/week/month (test ranges are categories for non-categorical results
  - For a result's test, it can display a Levy-Jennings plot (future; JSS is not entering data for controls)
- For rejected results, the system can create a retest specimen or lab order
  - Content is presented for editing to user
- For extreme results, the approver contacts the doctor and notes the event
- The approver can approve the report

Contents of a Lab Report

- Header identifying laboratory
- Patient name, IDs
- Ordered by name/address
- Lab orders to which report is responsive
- For each specimen: IDs, comments
  - For each panel: analyst, date/time, comments
    - For each test: name, result, flags, test range
- Approver name/signature, date/time

Release Process

- Release to encounter/obs is automatic
- Registration desk selects a report for release
  - Prints report if necessary
- Registration desk notes report delivery

Management

Periodic Reporting

- Number of tests performed
  - By section, analyst, panel
- Turnaround time
  - 10%ile, 50%ile, 90% by panel, urgent status
  - Percent of time within target by panel
- Results of tests performed
  - By sex, age group (typically pediatric/adult)
- Reasons for specimen rejection
  - By facility, provider
- Result rejection
  - By section, analyst, panel, analyst-panel

Features Not to be Developed

- Supply Item
  - Needed to record controls for quality control
  - Supply Item Xactn needed for inventory
- Instrument
  - Needed to record instrument use for quality control
  - Instrument Maintenance needed for quality control, asset control and downtime tracking