Laboratory Inventory Management System (LIMS)

Collect, track, aggregate, and query data from the field, during and after analyses using existing long-term cyberinfrastructure

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Data team
Problem: Collecting a lot of data, how to keep track of it all.
Problem

• Different workflows for each lab
• Labs need to collaborate with other labs
  • And other organizations
• Data from field and other labs need to be available to labs
Solution: Use available software

- Licensing expensive
- Not overarching enough
- Not one solution alone could solve it
- Future requirements may require additional software
Solution: Make LIMS

- Track items across various platforms
- Track items using QR codes
- Track items in the field
- Track items in the lab
- Analyze results
System Overview

API endpoints
Programmatic Access

Neo4j
Graph Database

MS SQL
Relational Database

Pathfinder
S3 Object Storage

ASP.NET

LIMS
Main Application

LIMS.FieldCollector
Mobile Application

android
LIMS tracks across multiple platforms
LIMS uses JSON to enable cross-platform functionality

- Build forms
- Capture data
- Generate output
- Give directions to widgets
- Uploads/downloads
LIMS uses QR codes to track items

• QR Codes
  • Built in redundancy in each code
    • Up to 30 percent of the code can be missing/damaged and still scan
LIMS uses QR codes to track items

- QR Codes
  - Double the storage capacity as a traditional barcode
    - Even more capacity if the code will not be used on a rounded surface
LIMS uses QR codes to track items

• QR Codes
  • QR code scanners can scan QR codes and barcodes
    • Most devices with a camera can be configured to read a QR code
LIMS uses QR codes to track items

- Labels
  - Small enough to fit on the smallest container to be tracked
  - Adhesive and paper designed for up to -196 C
LIMS uses QR codes to track items

• Labels
  • Special barcode printer not required
  • Sealer applied after printing for increased resistance of code damage
LIMS uses QR codes to track items

• Custom QR Code Generator
  • Can print a custom set of QR codes
    • Formatted to fit codes on a sheet of labels
  • Printed codes are ‘checked out’ from the database
    • When these show up again we know who requested them and when
LIMS uses QR codes to track items

• Custom QR Code Generator
  • Human readable non-arbitrary codes included on each label
    • In case it can’t scan or no access to the database. E.g., MyProj-Site1-001
  • Double the storage capacity as a traditional barcode
    • Allows for more custom naming schemes
LIMS tracks items in the field

The world needs more adventurous spirit.
LIMS tracks items in the field

- LIMS.FieldCollector
  - Android application
    - Available only to devices enrolled in our Android Enterprise
    - Allows for granular management of devices running application
LIMS tracks items in the field

- LIMS.FieldCollector
  - Features:
    - Data uploaded, parsed, and saved to LIMS database backed up nightly
    - Allows for custom forms to be made on request
      - Multiple research projects at the same site on the same or multiple devices
    - Can be adjusted
      - E.g. drop downs menus of commonly entered data, requiring that pictures are taken, etc.
LIMS tracks items in the field

- LIMS.FieldCollector
  - Features:
    - Does not need internet to collect data
    - Uploads data when there is internet
    - 8 “Data-kits” available for use
      - Tablet, Bluetooth QR code scanner, GPS, measuring tape, compass, external battery, solar charger, charging cables, protective cases, pens, markers, and paper.
LIMS tracks items in the lab
LIMS tracks items in the lab

- ASP.Net Web Application:
  - Available only to users on with a UW login
  - Users assigned different roles, e.g. Lab manager, for varying levels of access to application functionality
LIMS tracks items in the lab

• ASP.Net Web Application:
  • Manages uploads from and downloads to FieldCollector
  • Completed datasheets, photo uploads, updated plant species lists, etc.
LIMS tracks items in the lab

- ASP.Net Web Application:
  - Uses ARCC’s new on premises S3 storage system “Pathfinder”
  - MSSQL databases backed up nightly
  - Subset of DataCorral
  - Neo4j graph database
LIMS tracks items in the lab

• LIMS Works like a shipment tracker
  • Samples must be 'checked out' to a user from a storage location while performing analyses.
    • e.g. the shipment has left the storage facility at X:XX by Y observer for Z protocol.
LIMS tracks items in the lab

• LIMS Works like a shipment tracker
  • Samples must be 'checked in' to a storage location when the analyses are complete.
  • e.g. the shipment has been delivered to X lab in Y location by Z observer.
LIMS tracks items in the lab

- Unique protocols per workflow, made to lab manager requirements
  - Versioned; can be updated on the fly.
    - (e.g., doesn't require development time or redeployment)
LIMS tracks items in the lab

- Unique protocols per workflow made to lab manager requirements
  - Different types of data can be collected
  - Strict validation can be enforced or ignored
  - Built in JSON
LIMS tracks items in the lab

- Data from FieldCollector available as soon as its uploaded.
  - Samples have a history traced back to when it was first collected
  - Compare with other samples originated at the same site on the same day
LIMS tracks items in the lab

• Users can do actions for other users
  • Results and sessions are linked to what others are doing in real time
  • Possible to have multiple computers working on the same job
    • Even as the same user if desired
  • Finish a job that someone else had started.
LIMS gets the results
LIMS gets the results

• Access results programmatically using RemoteDb API
  • Allows for requests to be sent directly to the database for custom access
  • R scripts are written and shared among researchers
LIMS gets the results

• User interface to view total context of sample history
  • Pictures and original collection data from mobile application
  • Subsequent analyses and derived samples
  • Export results for further analysis
LIMS gets the results

- Results can optionally be exported from each protocol
  - On button click for immediate download
  - Emailed to current user, whoever they select, and the lab manager
Questions?

The world needs more adventurous spirit.
Acknowledgments

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