H43B-1235: Berkeley Sensor Database (BSD)
An Implementation of CUAHSI’s ODM for the Keck HydroWatch Wireless Sensor Network

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ABSTRACT

The Keck HydroWatch Project is a multidisciplinary project devoted to building a mechanistic understanding of the pathways, rates, and consequences of water movement through the soil, weathered bedrock, vegetation and return to atmosphere. Two key issues have been identified for intensive study: fractured rock water and hydraulic lift & redistribution. It is experimenting with novel techniques to monitor and trace water pathways through these mediums, including developing an intensive wireless sensor network. The Berkeley Sensor Database was designed to manage the large volumes of heterogeneous data coming from this sensor network. This system is an open source superset of the Observations Data Model (ODM) developed by the Consortium for Universities of the Advancement for Hydrologic Science, Inc. (CUAHSI).

Why modify HIS?

1. Intensive field site requires active management features:
   - Allow for the movement and reuse of devices (datastreams)
   - Record changes in sensors or accidents (insect reports)
   - Miscellaneous to configure automated data loading (stations)
   - Automated Quality Checks (collections)
2. Institutional mandate to develop on open source platforms
3. Keck HydroWatch multi-site data (data access or support for Microsoft Platform)

Database Schema

Project Requirements:
- Optimal web-based queries on a large DB.
- Flexible user interface & analysis & visualization tools.
- Access control & access control.
- Update model for broader range of sensors (e.g. flow, pressure).

Implementation:
1. Modify some tables.
   - Table facts (e.g. datastream 17 > 8 fields)
   - Table data (e.g. datastream 17 > 8 fields)
   - Add business rules to some tables
   - Data for some tables are stored elsewhere (e.g. Curation data)
2. Delay implementation for some tables (e.g. curation) tables.

Access Control

Project Requirements:
- Access control to research-level data.
- Private datasets in research.

Implementation:
- User accounts & passwords (including "guest")
- Access levels for each person
- Access levels for each sensor in collection

Data Quality

Data Workflow

Data Quality Levels


Support & Collaborations

Conceptual Design

Management Functions

Project Requirements:
- Web-based management tool
- Remote device configuration

Implementation:
- Create new devices, datastream, sites, etc.
- Interface with Microsoft Office Access & Excel
- Edit of ODM metadata (methods, variables, units, etc.)
- Automated email alerts for error conditions
- Automated alerts on schema modifications
- Monitor equipment & data acquisition
- View up-to-the-minute data (cloud, dashboard)

Researcher Interface

Project Requirements:
- Public access to data
- Privacy of research data

Implementation:
- Create researcher interface (schema)
- Download query results
- Upload measurement data
- Data query/download: view flags, view details, and table data

Quality Control

Project Requirements:
- Store all versions of data (raw, converted, cleaned)
- Allow access to data (by request)

Implementation:
- Data Quality Levels (Data Quality Control based on metadata)
- Data cleaned in month/quarter schema checks + incidents
- Loader performs sanity checks & flags data (if ODM, LIMS)
- Data Quality Level tag for raw.
- Incident Reports: users can flag data
- Data query/download: view flags, include flagged data

Networks: Workflow

- Networks connect distributed stations with Researcher Interface
- Logistical software (Campbell Scientific) in data capture routine
- Remote recognition & quality monitoring performed through Logistical
- Quality control of data is done as a user-level quality equivalent value (QV)
- Files are encrypted every 30 minutes to BSD server

Informatics: Data Loader

- The Data Loader runs every 30 minutes for a variety of loggers types (CR-10X, Prologger, Prologger, etc.)
- Data is imported and loaded into the database via FTP
- Multi-threaded import job
- Checks for new data arriving from the sensors
- Performs sanity check flags & exports
- Enforces daily export
- Exports to WDD
- Interprets environmental data as needed

Support & Collaboration


Wireless Networks

Angelo Reserve has a multi-tiered wireless network.

TIER 1: Backbone Network
- Provide wireless access to the Reserve.
- Support point-to-point network.
- Support point-point-to-point
- Support point-to-multipoint network.
- Support multipoint access.

TIER 2: Campell Scientific Field Network
- Connects all wireless Reserve stations to the Backbone network.
- Support point-to-multipoint wireless network.
- Support point-to-point wireless network.
- Support multipoint access wireless network.

TIER 3: Reserve housing and select outposts in the field.
- Provide internet access for researchers with laptop.
- Support point-to-point wireless network.

Wireless Access

- Wireless Access System (WAS) in situ.
- Connects wireless Reserve stations to the Backbone network.
- Support point-to-multipoint wireless network.
- Support point-to-point wireless network.
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