



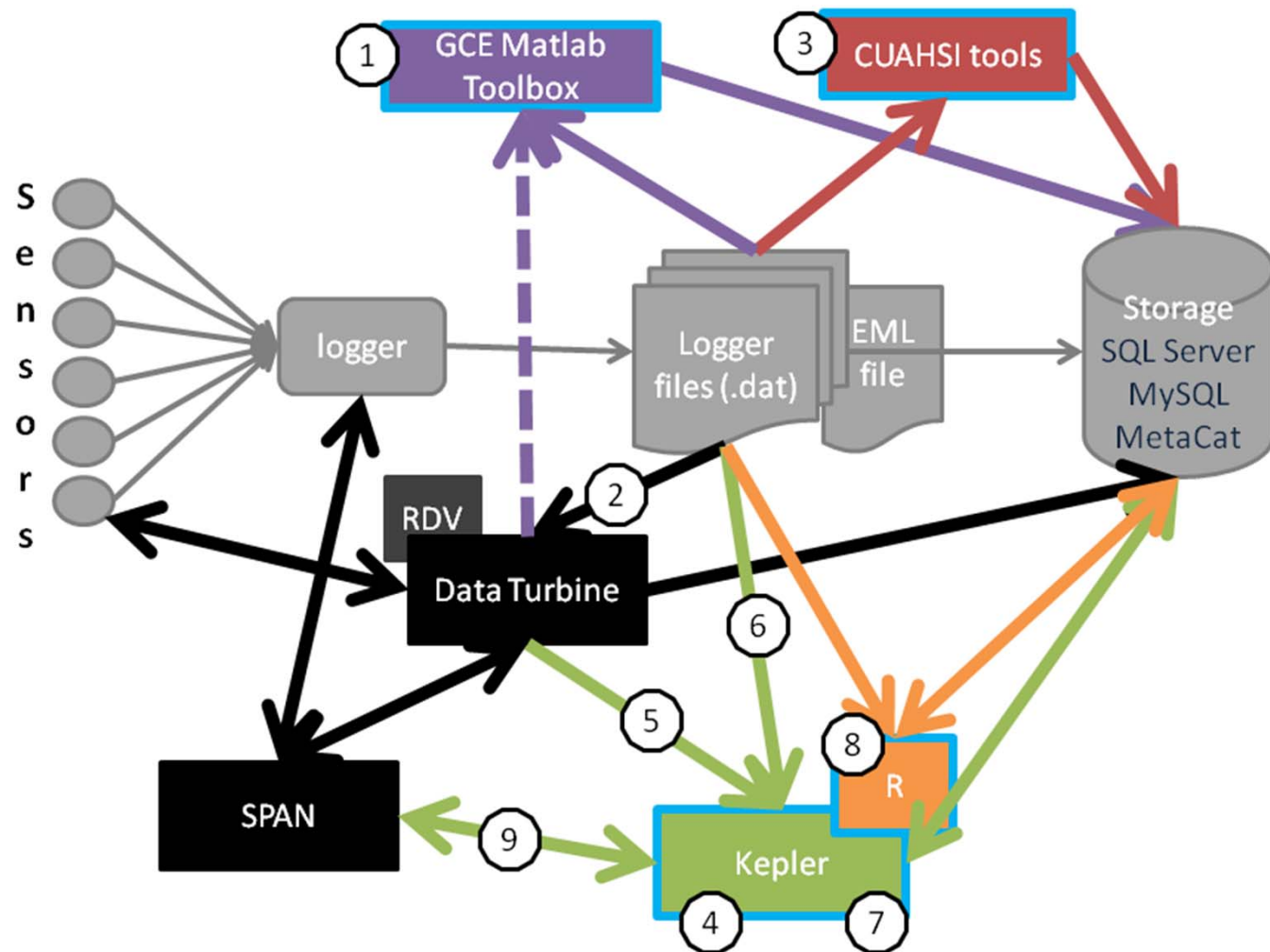
Integration of Data Turbine, MATLAB and CUAHSI ODM – NSF SI2 Demonstration Project

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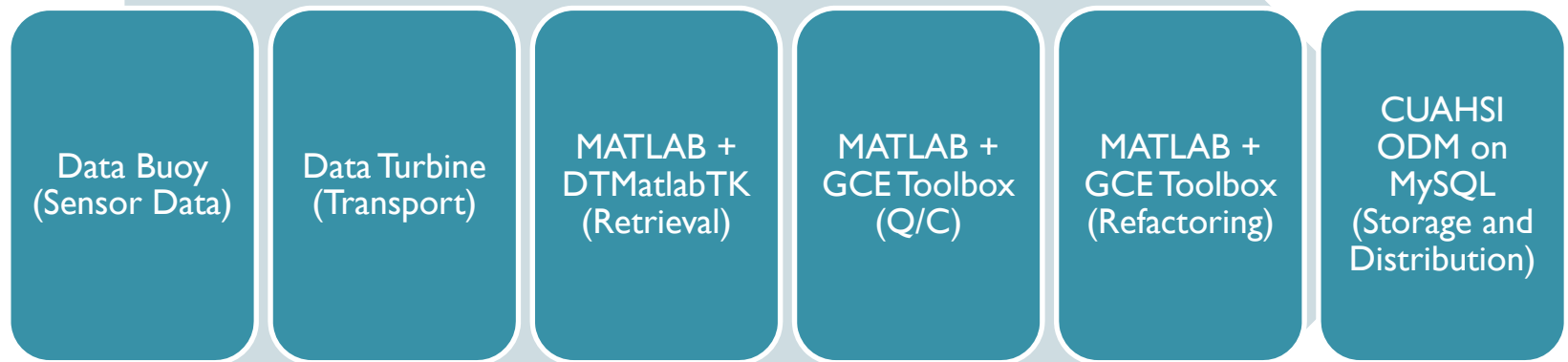
Chad Sebranek (NTL-LTER)

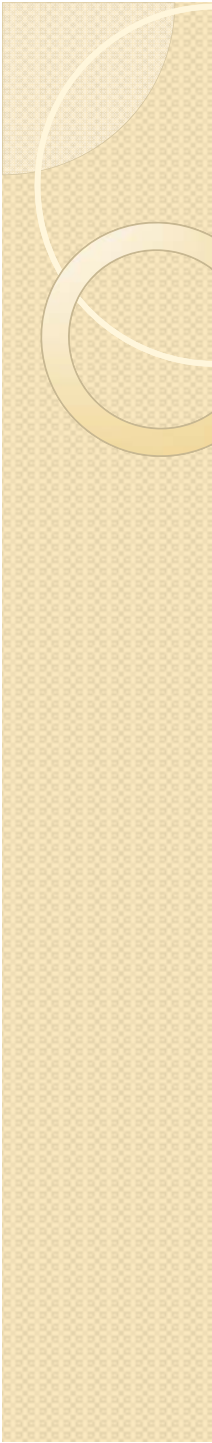
Potential Sensor Data Workflows



Analytical Pathway

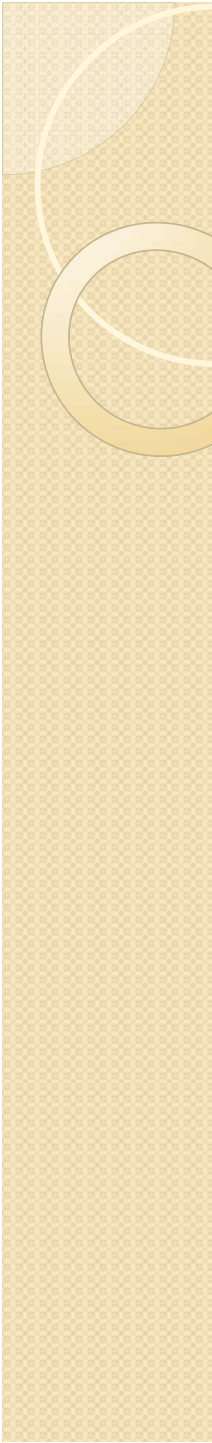
- Integration of Data Turbine, MATLAB and CUAHSI ODM
- Data Turbine to MATLAB via Java API (DTMatlabTK)
- MATLAB to ODM via JDBC





Data Turbine and MATLAB

- New MATLAB function library for Data Turbine (DTMatlabTK)
 - DTlist.m – get source and channel lists from DT server
 - DTget.m – get channel data from DT server
 - DTput.m – put data on a DT server
 - etc.
- Extended MATLAB function library (DTMatlabGCE) that provides higher level data management functions
 - Simplified functions for getting latest data
 - Handles all date math, time zone offsets automatically
 - Supports automated harvests with data integration, email alerts
 - “Bridge” to GCE Data Toolbox (support functions in GDT)
- DTMatlabTK and DTMatlabGCE will be available on OSDT website



DTMatlabGCE Functions

- **General Data Turbine Utilities**
 - DTlatest -- Retrieves all data from a DataTurbine server after a specified starting date
 - DTalign -- Aligns channels in a DTstruct returned from DTget to create a unified data structure
 - DTappend -- Appends channel data retrieved from DTget or DTlatest to existing channel data
 - DTcombine -- Combines channel data retrieved in multiple requests from a Data Turbine server
- **Data Turbine to GCE Toolbox Utilities**
 - DTsource2gce -- Imports channels from a Data Turbine source to create a GCE Data Structure
 - DTchan2gce -- Converts data returned from DTalign into a GCE Data Structure
- **Data Turbine Data Harvester**
 - DTharvest -- Manages automatic retrieval and archiving of channel data from a Data Turbine source
 - DTharvestStruct -- Generates an options structure for use with DTharvest.m
- **Helper Functions**
 - date2sec -- Calculates cumulative seconds past a reference date from a MATLAB serial date
 - sec2date -- Calculates a MATLAB serial date from cumulative seconds past a reference date
 - getUTCOffset -- Calculates the offset of the computer clock from UTC due to time zone settings
 - fillDateTokens -- Replaces date/time field tokens in strings with current date/time information

Data Turbine to MATLAB

Fetch Data Turbine Data

Specify a Data Turbine Server and Source

Server: localhost Source: TroutBog ?

Start Date: 4/11/2013 Time offset (h): 0 Days/Request: 0

Template: NTL_TroutBog

Cancel ☒ Close dialog ☐ Open data in new window Proceed

Data imported from Data Turbine source 'TroutBog' on server local...

File Edit Metadata Tools Misc Window Help

Column Select to display properties

Date (serial day (base 1/1/0000))

RECORD

TpLn00 (°C)

TpLn05 (°C)

TpLn10 (°C)

TpLn15 (°C)

TpLn20 (°C)

TpLn25 (°C)

TpLn30 (°C)

TpLn40 (°C)

TpLn50 (°C)

TpLn70 (°C)

airTemp (°C)

dataloggerBat (volts)

radioBat (volts)

relHum (%)

Move First

Move Up

Move Down

Move Last

Preview

Histogram

Manual QC

Add

Delete

Restore

Column Name Date

Column Units serial day (base 1/1/0000) Convert

Description

Calendar date and time of observation

Data Type floating-point number (f)

Variable Type date or time (datetime)

Numerical Type continuous/ratio (continuous)

Precision 8 decimal places

Flag Criteria Edit

Refactoring Table to ODM

Data imported from Data Turbine source 'TroutBog' on server local...

File Edit Metadata Tools Misc Window Help

Column List (select to display properties)

Date (serial day (base 1/1/0000))

RECORD

TpLn00 (°C)

TpLn05 (°C)

TpLn10 (°C)

TpLn15 (°C)

TpLn20 (°C)

TpLn25 (°C)

TpLn30 (°C)

TpLn40 (°C)

TpLn50 (°C)

TpLn70 (°C)

airTemp (°C)

dataloggerBat (volts)

radioBat (volts)

relHum (%)

Move First

Move Up

Move Down

Move Last

Preview

Histogram

Manual QC

Add

Delete

Restore

Column Name Date

Column Units serial day (base 1/1/0000)

Description

Calendar date and time of observation

Data Type floating-point number (f)

Variable Type date or time (datetime)

Numerical Type continuous/ratio (continuous)

Precision 8 decimal places

Flag Criteria

ODM DataValues Export Table for Site TB (generated 25-Apr-2013 0...

File Edit Metadata Tools Misc Window Help

Column List (select to display properties)

DataValue

LocalDateTime (yyyy-mm-dd HH:MM:SS)

UTCOffset (hours)

DateTimeUTC (yyyy-mm-dd HH:MM:SS)

SiteID (none)

VariableID (none)

OffsetValue (m)

SensorCode

QualifierID

MethodID (none)

SourceID

QualityControlLevelID

Move First

Move Up

Move Down

Move Last

Preview

Histogram

Manual QC

Add

Delete

Restore

Column Name DataValue

Column Units

Description

Combined values from normalization of data columns RECORD, TpLn00, TpLn05, TpLn10, TpLn15, TpLn20, TpLn25, TpLn30, TpLn40, TpLn50, TpLn70, airTemp, dataloggerBat and radioBat

Data Type floating-point number (f)

Variable Type measurements (data)

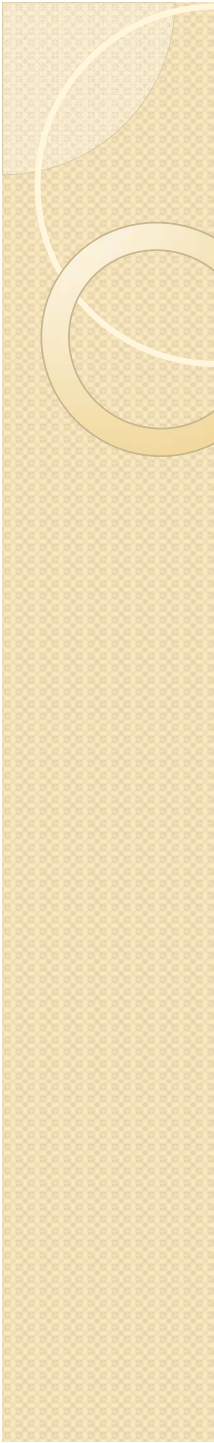
Numerical Type continuous/ratio (continuous)

Precision 7 decimal places

Flag Criteria manual

Prep Work

- Register Site, Methods and other program metadata in ODM
- Register Data Turbine channels as variables in ODM
- Create GCE metadata template with channel names, Q/C rules
- Register qualifiers used in Q/C rules in ODM to create QualifierIDs
- Export 'qualifiers' table from ODM, import into GCE Data Toolbox via SQL or ASCII import (odm_qualifiers.mat)
- Create ODM channel mapping dataset (odm_channel_mapping.mat):
 - SiteCode (string)
 - SiteID (integer)
 - Channel (string)
 - VariableID (integer)
 - MethodID (integer)
 - OffsetValue (floating-point)
 - NoDataValue (floating-point)



Refactoring Steps

- Combine multiple data columns to create “skinny” table (Date, Channel, DataValue, ...)
- Convert Q/C flags to text columns (Flag_DataValue)
- Join to ODM variable mapping table (Channel==Channel)
- Join to ODM qualifier table (Flag_DataValue==QualifierCode)
- Call ‘gce2odm.m’ to generate SiteID, UTC and local date
- Call ‘gce_fastinsert.m’ to upload arrays to ‘datavalues’ table in MySQL (requires MATLAB Database toolbox)
- Verify data upload using MySQL Workbench