

# Crossing a new frontier in hydrometeorological data management with an **I**ntegrated **S**ensor **D**ata **M**anagement **S**ystem (**ISDMS**)

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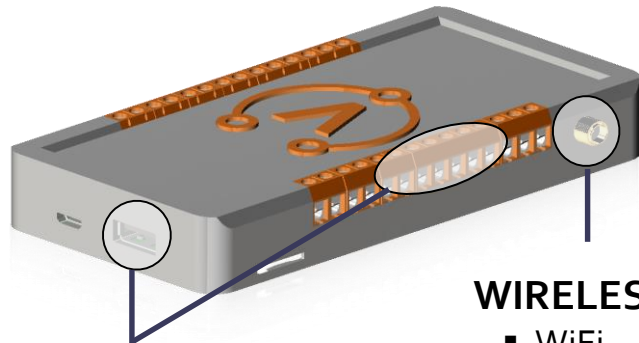


# About ISDMS

## What is ISDMS?

**ISDMS** is an end-to-end solution to capture, manage, analyze, and share environmental data and corresponding metadata. Key Differentiator: **transform data to information!**

**ISDMS = Hardware (named TranscodX)**



### SERIAL

- USB 2.0
- I<sup>2</sup>C
- 1-Wire
- SDI-12
- Modbus

### WIRELESS

- WiFi
- Bluetooth
- Zigbee
- Cellular capable

+

**Software Framework**



**TCAST** – Transcoder Configuration and Auto-programming Software Tool for TranscodX deployment



**DATALYTICS** – Users view and analyze data



**TRANSCONET** – Users create networks of deployed Transcoders



**DATAVAULT** – Users download and share data in a variety of standardized exportable formats

**Virtual TranscodX** <https://tcast.sensaq.com/tcast/virtualtranscoder>

# Examples of Issues with Datalogger-borne Data Files

```
"TOA5", "CR1000", "CR1000", "47077", "CR1000.Std.24", "CPU:Base Station Last Version.CR1", "51687", "Beloc
"TIMESTAMP", "RECORD", "R_H_Max", "R_H_TMx", "Air_TC_Avg", "Slr_W_Avg", "Slr_MJ_Tot", "Rain_inch_Tot", "Win
"TS", "RN", "%", "%", "Deg C", "W/m^2", "MJ/m^2", "inch", "meters/second", "degrees", "%", "%", "Volts"
", "", "Max", "TMx", "Avg", "Avg", "Tot", "Tot", "Avg", "Avg", "Avg", "Avg", "Avg"
"2013-11-23 23:00:00", 2555, 90.7, "2013-11-23 22:57:35", 22.97, 0, 0, 0, 0, 77.63, 7999, 0.912, 12.16
"2013-11-24 00:00:00", 2556, 91.1, "2013-11-23 23:17:45", 23.01, 0, 0, 0, 0, 88.8, 7999, 0.912, 12.14
"2013-11-24 01:00:00", 2557, 91.1, "2013-11-24 00:13:30", 23.26, 0, 0, 0, 0, 74.95, 7999, 0.912, 12.13
"2013-11-24 02:00:00", 2558, 90.5, "2013-11-24 01:00:35", 23.73, 0, 0, 0, 0, 74.95, 7999, 0.912, 12.13
"2013-11-24 03:00:00", 2559, 89.6, "2013-11-24 02:59:45", 23.55, 0, 0, 0, 0, 95.2, 7999, 0.912, 12.09
"2013-11-24 04:00:00", 2560, 90.2, "2013-11-24 03:37:40", 22.92, 0, 0, 0, 0, 74.95, 7999, 0.912, 12.07
"2013-11-24 05:00:00", 2561, 90.4, "2013-11-24 04:58:20", 22.74, 0, 0, 0, 0, 78.76, 7999, 0.912, 12.05
```

**Insufficient Metadata**

## Heterogeneities

- Syntactic
- Schematic
- Semantic

Date/Time	P1:PYR Solar Radiation W/m²	P2:DS-2 Sonic Anemometer °	P2:DS-2 Sonic Anemometer m/s	P2:DS-2 Sonic Anemometer m/s	P3:REC-1 Precipitation/EC mS/cm	P3:REC-1 Precipitation/EC mm	P4:VP-4 Humidity/Temp/Ba rometer kPa	P4:VP-4 Humidity/Temp/Ba rometer RH	Hum	
23/Oct/2002 00:05	34.79	4	3.40	1.31	0.00	0.00	101.10	0.64		
23/Oct/2002 00:10	32.96	7	2.40	1.20	0.00	0.00	101.09	0.63		
23/Oct/2002 00:15	21.97	10	3.30	1.28						
23/Oct/2002 00:20	27.47	11	2.50	1.03	"TOA5", "CR1000", "CR1000", "47077", "CR1000.Std.24", "CPU:Base Station Program last.CR1", "25642"					
23/Oct/2002 00:25	25.63	10	3.40	1.44	"TIMESTAMP", "RECORD", "FD_Rain_in_TOT", "FD_AirTC_AVG", "FD_RH_MAX", "FD_RH_TMx", "FD_VW_AVG", "FD					
23/Oct/2002 00:30	31.13	10	2.40	1.20	"TS", "RN", "inch", "Deg C", "%", "%", "%", "W/m^2", "MJ/m^2", "meters/second", "meters/second", "Deg",					
23/Oct/2002 00:35	34.79	7	3.10	1.39	", "", "Tot", "Avg", "Max", "TMx", "Avg", "Avg", "Tot", "Avg", "WVc", "WVc", "WVc", "Avg"					
23/Oct/2002 00:40	32.96	6	2.90	1.18	"2013-06-07 10:00:00", 0, 0, 23.64, 100, "2013-06-07 09:00:50", 0.171, 0, 1.692245E-006, 1.938, 1.938,					
23/Oct/2002 00:45	23.80	6	3.20	1.20	"2013-06-07 10:01:00", 1, 0, 25.98.6, "2013-06-07 10:03:20", 0.171, 0.001, 3.384018E-006, 2.125, 2.12					
23/Oct/2002 00:50	21.97	11	2.40	1.11	"2013-06-07 12:00:00", 2, 0, 25.34, 88.4, "2013-06-07 11:07:25", 0.171, 0, 1.69181E-006, 2.184, 2.184,					
23/Oct/2002 00:55	21.97	5	2.10	1.19	"2013-06-07 13:00:00", 3, 0, 25.19, 89.2, "2013-06-07 12:13:50", 0.17, 0.008, 2.876077E-005, 2.38, 2.3					
23/Oct/2002 01:00	9.16	352	1.70	0.62	"2013-06-07 14:00:00", 4, 0, 23.55, 100, "2013-06-07 13:19:10", 0.171, 0.002, 6.767278E-006, 2.083, 2.					
23/Oct/2002 01:05	5.49	281	1.60	0.41	"2013-06-07 15:00:00", 5, 0, 23.57, 100, "2013-06-07 14:02:10", 0.171, 0.003, 1.015158E-005, 3.634, 3.					
23/Oct/2002 01:10	56.76	275	2.20	0.40	"2013-06-07 16:00:00", 6, 0, 23.17, 96.5, "2013-06-07 15:33:05", 0.171, 0, 1.691874E-006, 4.046, 4.046					
23/Oct/2002 01:15	179.44	280	2.40	0.63	"2013-06-07 17:00:00", 7, 0, 22.25, 99.2, "2013-06-07 17:00:00", 0.171, 0.001, 5.077055E-006, 3.538, 3					
23/Oct/2002 01:20	289.31	290	1.80	0.46	"2013-06-07 18:00:00", 8, 0, 21.78, 100, "2013-06-07 17:31:10", 0.171, 0.001, 5.078115E-006, 2.744, 2.					
23/Oct/2002 01:25	327.76	264	1.50	0.41	"2013-06-07 19:00:00", 9, 0.04, -2.022, 100, "2013-06-07 18:01:00", 0.171, 0.003, 1.015763E-005, 2.13					
23/Oct/2002 01:30	195.92	290	1.80	0.42						

# Examples of Issues with Datalogger-borne Data Files

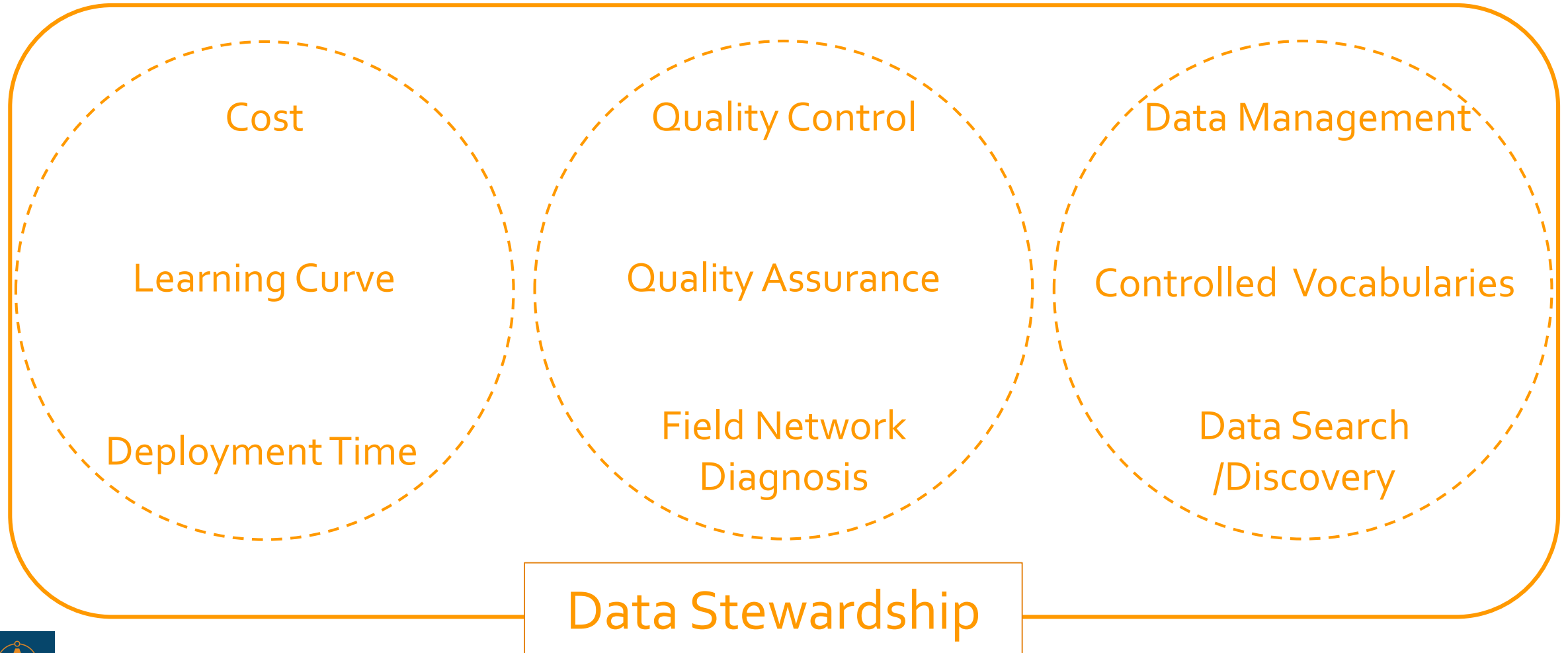
## Current Metadata Handling practices

Created in accordance with WMO metadata guidelines, as detailed in Aguilar et al, 2003 in WCDMP-5

SN	LOCAL_NAME	COUNTRYNAME	NAME_PRINCIPAL	LONDIR	LON	LON_D	LON_M	LON_S	EL_GROUND
X(30)	X(20)	X(100)	X		999	99	99	99	999999
	Name of station, upper case may contain characters, numbers or symbols.	Name of country, upper case.	Name of station, upper case may contain characters, numbers or symbols.	Longitude direction, blank indicates East and "-" indicates West.		Longitude degrees, 00 to 180 with leading zeros present.	Longitude minutes, 00 to 59 with leading zeros present.	Longitude seconds, 00 to 59 with leading zeros present.	Station elevation, meters, "-99999" indicates ground elevation is missing.
16	5G0F4266	GHANA	Asante Akyem Technology Institute - Ashant		- 1.17	01	10.00	0.80	
17	5G0F4276	GHANA	Ofoase Senior HTS		- 1.28	01	16.00	57.35	
18	5G0F4275	GHANA	Bompata Presby SHS		- 1.05	01	3.00	9.47	
19	5G0C1620	KENYA	Lela Primary School (replaced)		34.40	34	23	52.77	
20	5G0C1511	KENYA	Lela Primary School		34.40	34	23	52.77	
21	5G0C1613	KENYA	Koyoo Secondary School		34.61	34	36	26.14	
22	5G0F4264	KENYA	Homa Bay High School		34.46	34	27	36.60	
23	5G0F4288	KENYA	St Williams Osodo School		34.26	34.00	15.00	20.33	
24	5G0F4286	KENYA	Kisaju Woodlands Trust		36.86	36.00	51.00	44.63	
25	5G0F4255	KENYA	St. Michaels Kabisaga		35.17	35.00	10.00	25.36	
26	5G0F4271	KENYA	Bubayi-Saboti Farm		34.92	34.00	55.00	12.49	
28	5G0F4260	KENYA			0.00				
29	5G0F4267	RWANDA	Gashora Girls Academy		0.00				
30	5G0E3683	NIGERIA	FUTA Campus Wascal Station		5.15	05	08	49.5	
31	5G0F4259	NIGERIA	Maiduguri		0.00				
32	5G0C1471	SENEGAL	Ngouye Town Station		- 15.59	15	35	40.03	
33	5G0C1472	SENEGAL	Thies Town Station		- 16.95	16	56	46.95	
34	5G0C1621	SOUTH AFRICA	UKZN AIM Agrometeorological Instrumentat		30.40	30	24	10	

AK ADAK	500026	03	ALEUTIANS WEST	20021745	51*53'00"	-176*39'00"	17	19960731
AK ADULT CONSERVATION CAM	500040	05	MATANUSKA-SUSITNA BOROUGH	20022115	61*42'00"	-148*59'00"	830	19730701
AK AKIAK	500100	07	BETHEL	20022014	60*55'00"	-161*13'00"	-8	20030603
AK AKULURAK	500125	07	WADE HAMPTON	20022186	62*30'00"	-164*25'00"	30	19441231
AK AKUTAN	500144	03	ALEUTIANS EAST BOROUGH	20022525	54*08'00"	-165*46'00"	0	19900227
AK ALASKA PACIFIC UNIV	500172	05	ANCHORAGE BOROUGH	20022574	61*11'20"	-149*48'20"	220	20060929
AK ALEKNAGIK	500201	06	DILLINGHAM	20021916	59*17'00"	-158*34'00"	69	19730331
AK ALITAK BAY	500225	02	KODIAK ISLAND BOROUGH	20021828	56*53'00"	-154*15'00"	10	19640731
AK ALLAKAKET	500230	08	YUKON-KOYUKUK	20022367	66*33'55"	-152*38'33"	400	19980815
AK ALPINE	500235	01	NORTH SLOPE BOROUGH	30076589	70*20'47"	-150*55'42"	17	99991231

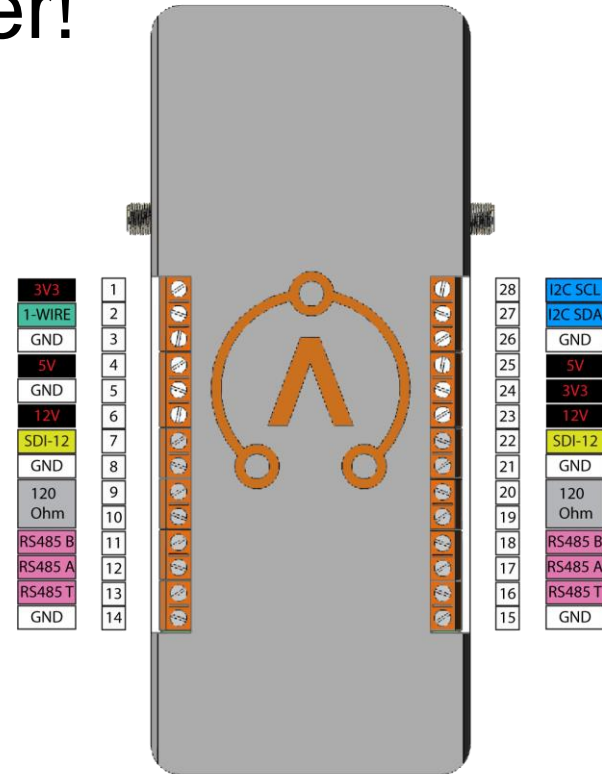
# Dataloggers: Their limitations



# ISDMS: Hardware

## A **Transcoder** rather than a Datalogger!

- ✓ Deployed with onboard deployment-context metadata (includes Controlled Vocabularies as well)
- ✓ Designed to serve sensor data & associated metadata
- ✓ Designed to autodetect and report attached sensors
- ✓ Auto-programmed



**TranscodX**

**Try our Virtual TranscodX!**

<https://tcast.sensaq.com/tcast/virtualtranscoder>



# ISDMS: Software Framework

## TCAST: Transcoder Configuration and Auto-programming Software Tool

- ✓ Designed to facilitate the provision of metadata to TranscodX and its auto-programming
- ✓ Incorporates Controlled Vocabularies developed by CUAHSI as part of the metadata entries
- ✓ Encodes the metadata using standardized formats (IEEE 1451.0 and WaterML)
- ✓ Includes a sensor information system

The screenshot displays the TCAST software interface. At the top, a progress bar shows the current step: **Transcoder Connection**. Below this, the **Transcoder Operation Information** section includes fields for **Transcoder Name \*** (TranscodXera), **Data Time Interval \*** (5), **Time Interval Units \*** (Minute), and **Number of Variables or Parameters to be collected \*** (5). A **Transcoder Deployment Location Inform** section is partially visible at the bottom.

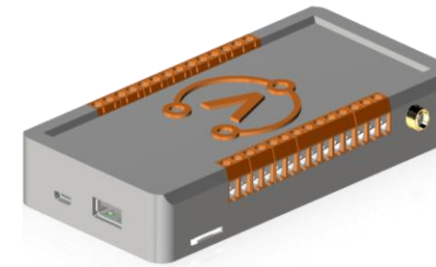
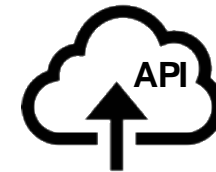
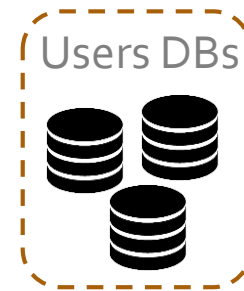
An inset window shows a table for configuring data collection. A red box highlights the **Variables**, **Units**, **Data Type**, and **Deployment Medium** columns. A red arrow points from the text **Controlled Vocabularies** to these columns. A **Continue to Program Generation** button is located at the bottom of the inset.

Order	Sensors	Variables	Units	Data Type	Deployment Medium	Confirmation
1	Select Sensor	Select Variable	Select Unit	Select Data Type	Select	Confirm
2	Select Sensor	Select Variable	Select Unit	Select Data Type	Select	Confirm
3	Select Sensor	Select Variable	Select Unit	Select Data Type	Select	Confirm
4	Select Sensor	Select Variable	Select Unit	Select Data Type	Select	Confirm

# ISDMS: Software Framework – Cont'd

**API:** for Data and Metadata Streaming to our Data Management framework

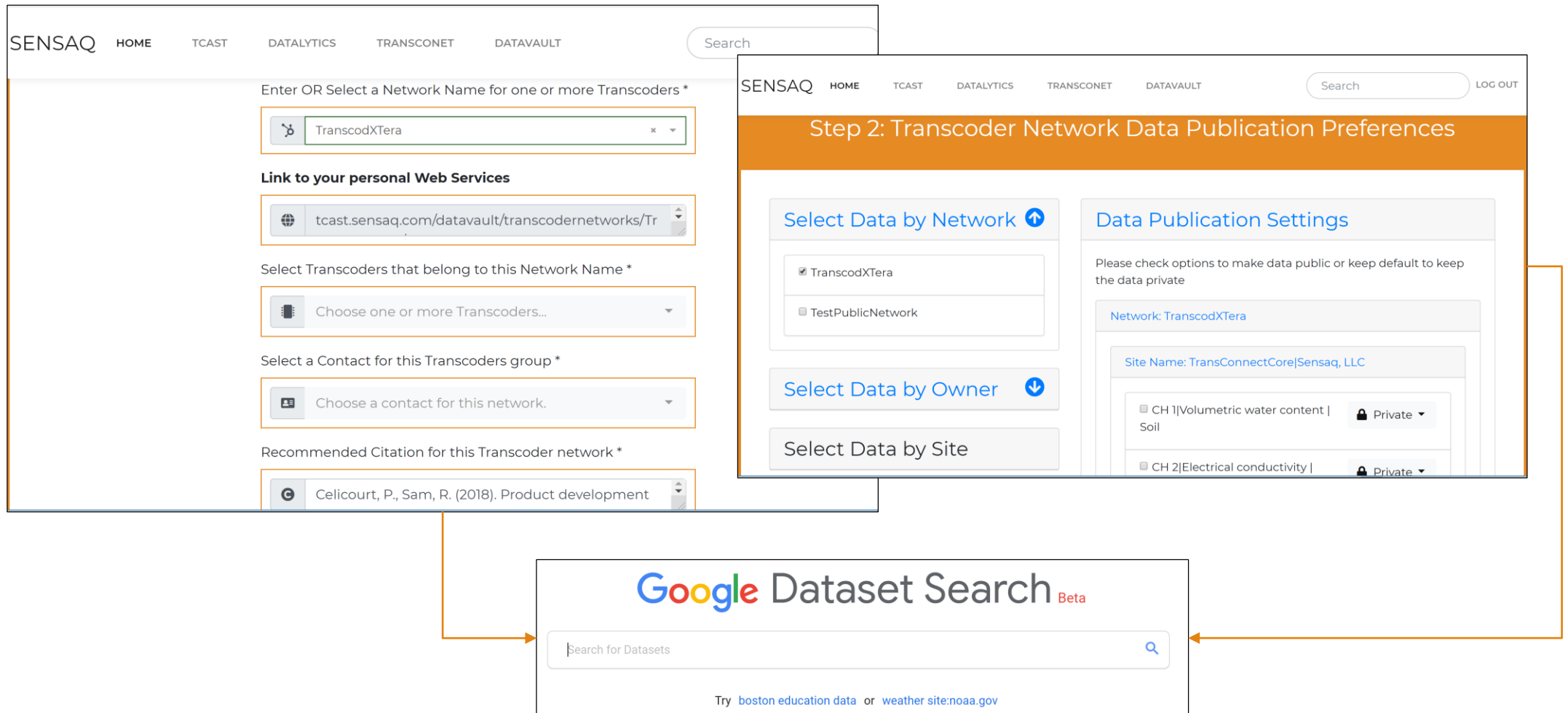
- ✓ Incoming data and corresponding metadata are automatically organized into an extension of the CUAHSI's Observations Data Model (ODM)





# ISDMS: Software Framework – Cont'd

**TranscoNet:** to create networks of transcoders and specify data sharing options



# ISDMS: Software Framework – Cont'd

**DataVault:** to access public & private data annotated with metadata

DataVault Data Portal

Data Repository Type \*  
Select a data repository type

Organizations \*  
Select an Organization

Transcoder Networks Repositories \*  
Select a Network Name

Controlled Vocabularies set  
CUAHSI

Data Formats \*  
XML(OGC WATERML 2.0)

Get Measurements

Get Measurement Values

Select a Transcoder \*  
Select a Variable \*

Select the data formatting

- XML(OGC WATERML 2.0) ✓
- JSON
- Excel
- CSV (comma-delimited)



HOME TCAST DATALYTICS TRANSCONET DATAVAULT Search LOG OUT

## Get Measurements

Get Measurement Values

Select a Transcoder \*

Choose a Transcoder

Select a Variable \*

Choose a Variable

Select a Unit (Optional)

Choose a unit

Select Time Period (Optional)

Start Time

End Time

Click here to get the data.



HydroUnits



# ISDMS: Software Framework – Cont'd

## Datalytics: a suite of tools for data analysis and visualization

The screenshot displays the Datalytics web interface. On the left is a sidebar with a 'SITES' section listing various sensor types: TranscodXTRa, SoilMonitorX, SoilMoistureMonitorX, TranscoSoilMoisture, TranscodXSoil, BPKTranscodX, TransdoxTest, Nelly's Office, TranscodXLatestTest, TranscodXLaTest, RadiatorEnv, TransConnectCore, Compare Variables, and Aggregate Plots. The main content area features a map titled 'Installed Transcoders: 12' with a line chart overlay showing 'Normalized values' for five channels (Channel 1 to 5) over a 24-hour period on Feb 11, 2018. To the right of the map, there are two data summary cards: 'Channel 1' for 'Volumetric water content' and 'Channel 2' for 'Electrical conductivity', both collected in soil every 5.0 minutes. Below the map is a control panel with a dropdown menu set to 'Volumetric water content of S', date pickers for '2018-02-03' and '2018-02-11', a unit dropdown set to '- variable unit -', and radio buttons for 'Bars', 'Line' (selected), and 'Violin', along with an 'outliers' checkbox. Two buttons, 'DOWNLOAD DATA' and 'UPDATE DISPLAY', are located below the control panel. At the bottom, a 'Time series of Volumetric water content collected in Soil' is shown as a line chart with a legend for time intervals: '1d', '7d', '1m', 'YTD', '1y', and 'all'.

# Beta Testing (Ongoing ...)

4 U.S. Universities deploying 5 stations



# Thank You!

