Crossing a new frontier in hydrometeorological data management with an Integrated Sensor Data Management System (ISDMS)

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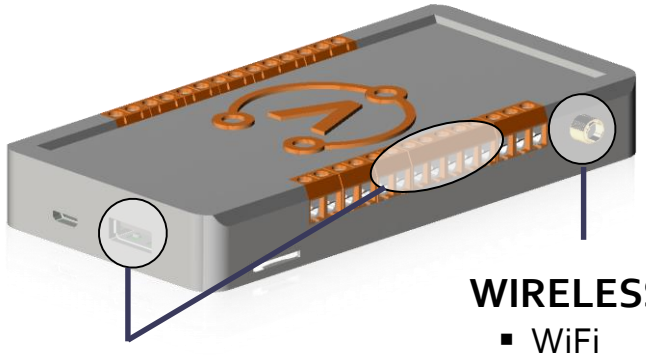
About ISDMS

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)	+	Software Framework



SERIAL
- USB 2.0
- I²C
- 1-Wire
- SDI-12
- Modbus

WIRELESS
- WiFi
- Bluetooth
- Zigbee
- Cellular capable

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

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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",23.26,0,0,0,0,74.05,7999,0.912,12.12
"2013-11-24 02:00:00",2558,90.5,"2013-11-24 01:00:35",23.78,0,0,0,0,74.8,7999,0.912,12.1
"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",22.92,0,0,0,0,78.76,7999,0.912,12.07
"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/Barometer kPa	P4:VP-4 Humidity/Temp/Barometer 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					
23/Oct/2002 00:25	25.63	10	3.40	1.44					
23/Oct/2002 00:30	31.13	10	2.40	1.20					
23/Oct/2002 00:35	34.79	7	3.10	1.39					
23/Oct/2002 00:40	32.96	6	2.90	1.18					
23/Oct/2002 00:45	23.80	6	3.20	1.20					
23/Oct/2002 00:50	21.97	11	2.40	1.11					
23/Oct/2002 00:55	21.97	5	2.10	1.19					
23/Oct/2002 01:00	9.16	352	1.70	0.62					
23/Oct/2002 01:05	5.49	281	1.60	0.41					
23/Oct/2002 01:10	56.76	275	2.20	0.40					
23/Oct/2002 01:15	179.44	280	2.40	0.63					
23/Oct/2002 01:20	289.31	290	1.80	0.46					
23/Oct/2002 01:25	327.76	264	1.50	0.41					
23/Oct/2002 01:30	195.92	290	1.80	0.42					

```
"TOA5","CR1000","CR1000","47077","CR1000.Std.24","CPU:Base_Station_Program_last.CR1","25642"
"TIMESTAMP","RECORD","FD_Rain_in_TOT","FD_AirTC_AVG","FD_RH_MAX","FD_RH_TMx","FD_VW_AVG","FD
"TS","RN","inch","Deg C","%","%","%","W/m^2","MJ/m^2","meters/second","meters/second","Deg",
"","","Tot","Avg","Max","TMx","Avg","Avg","Tot","Avg","WVc","WVc","WVc","Avg"
"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,
"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
"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,
"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
"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.
"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.
"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
"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
"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.
"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
```

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

Red = Information needed for webportal metadata

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	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 missi
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	-9
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	

Basic Station Metadata | Overview of metadata label desc | Instrumentation Details

```
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
```

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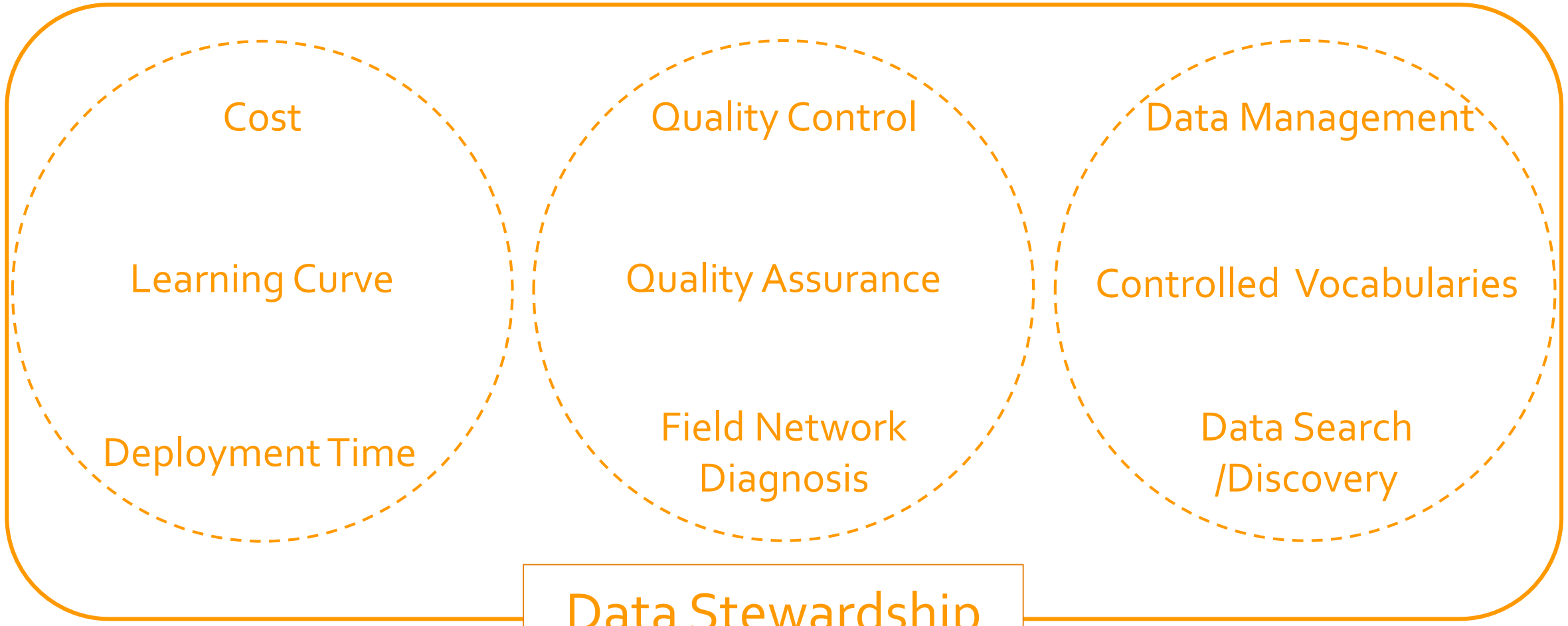
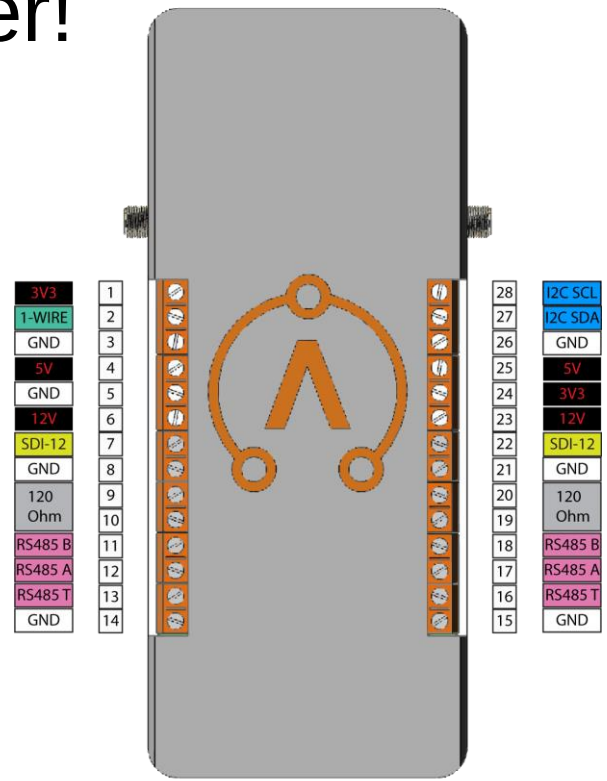
Dataloggers: Their limitations



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

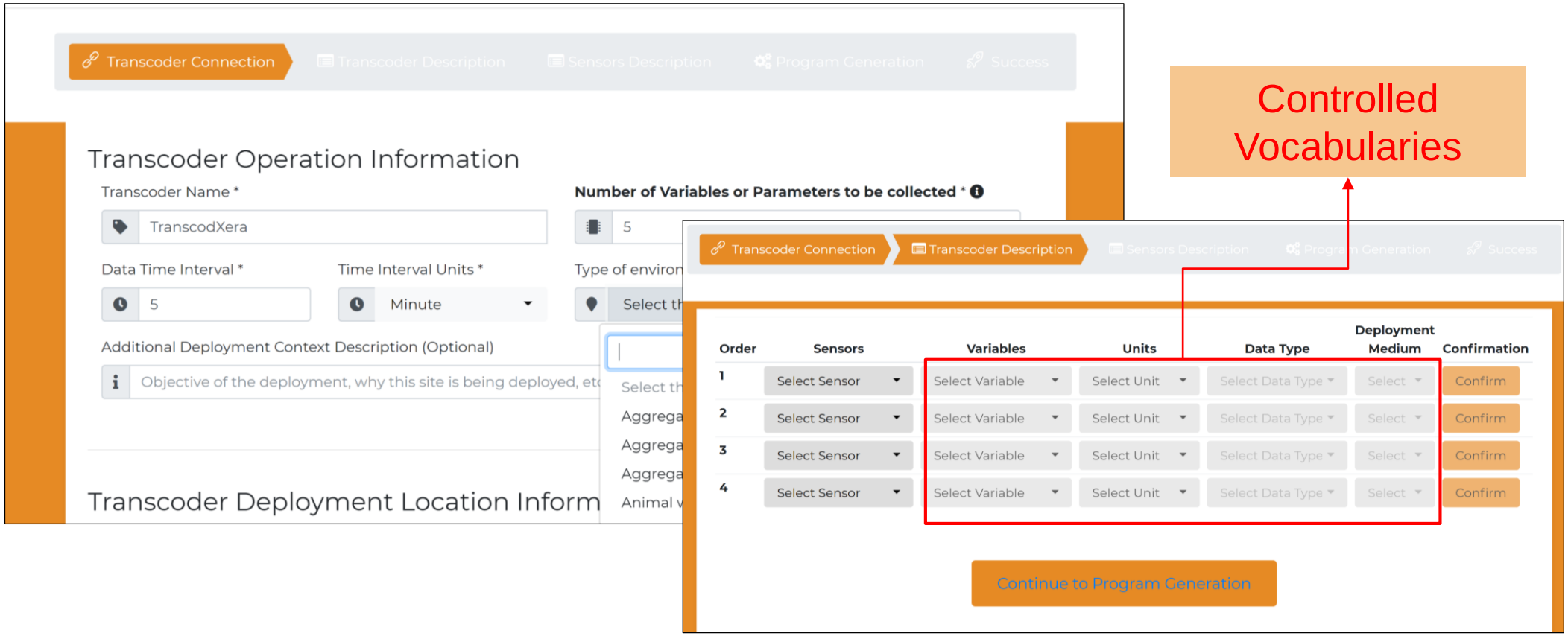
Try our Virtual TranscodX!

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



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)

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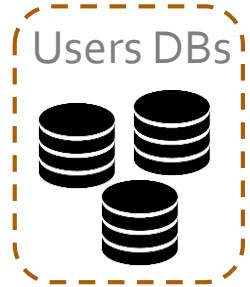

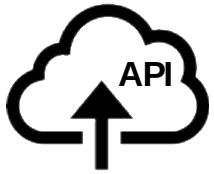

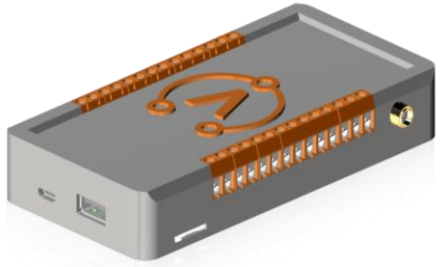

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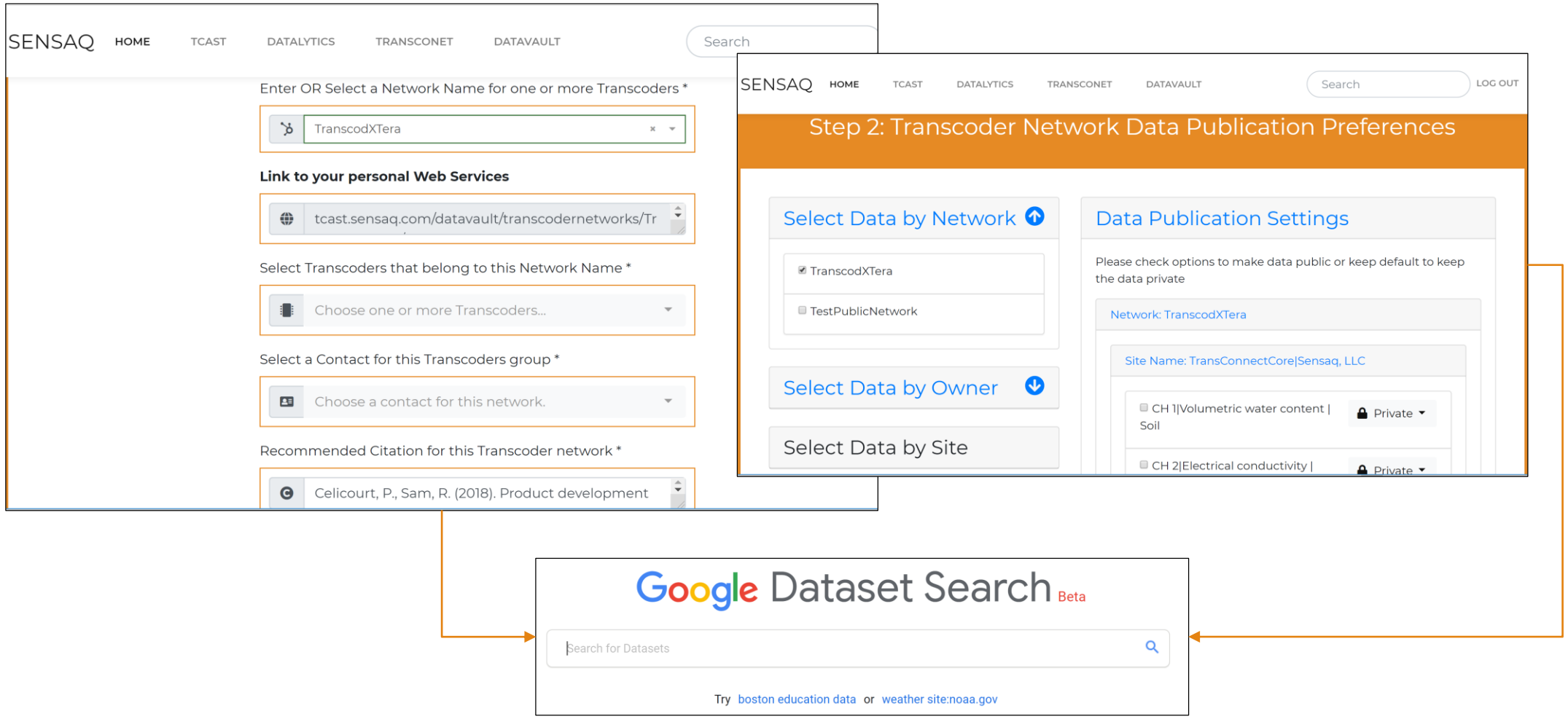
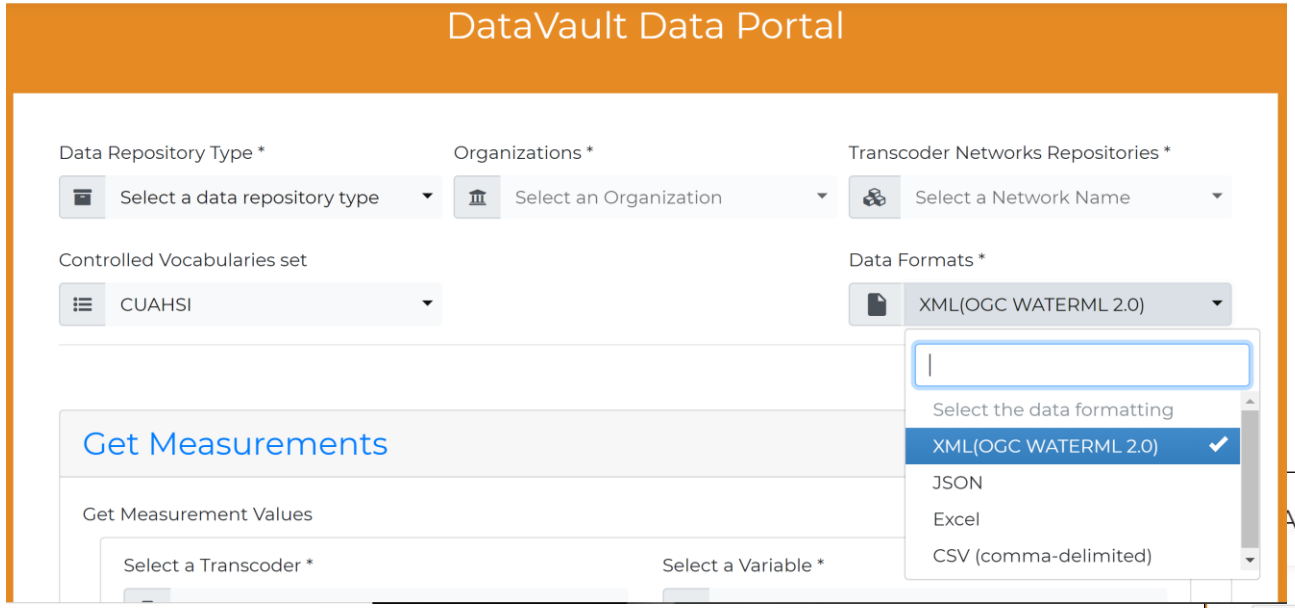
ISDMS: Software Framework – Cont'd

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



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Making location count.

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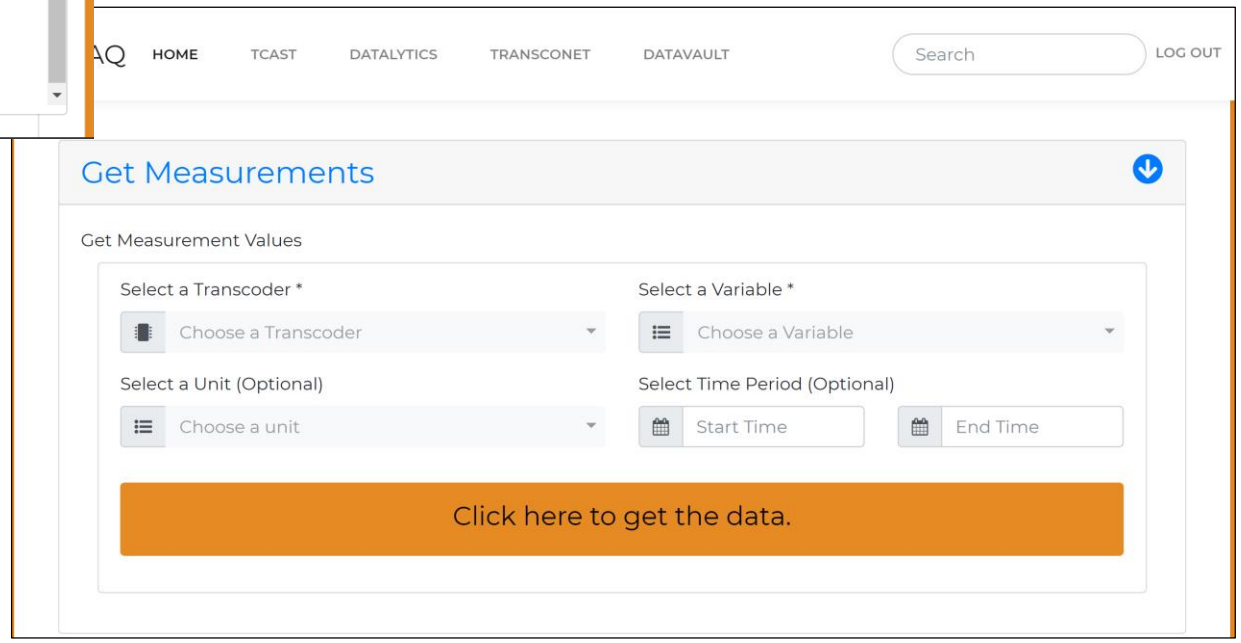

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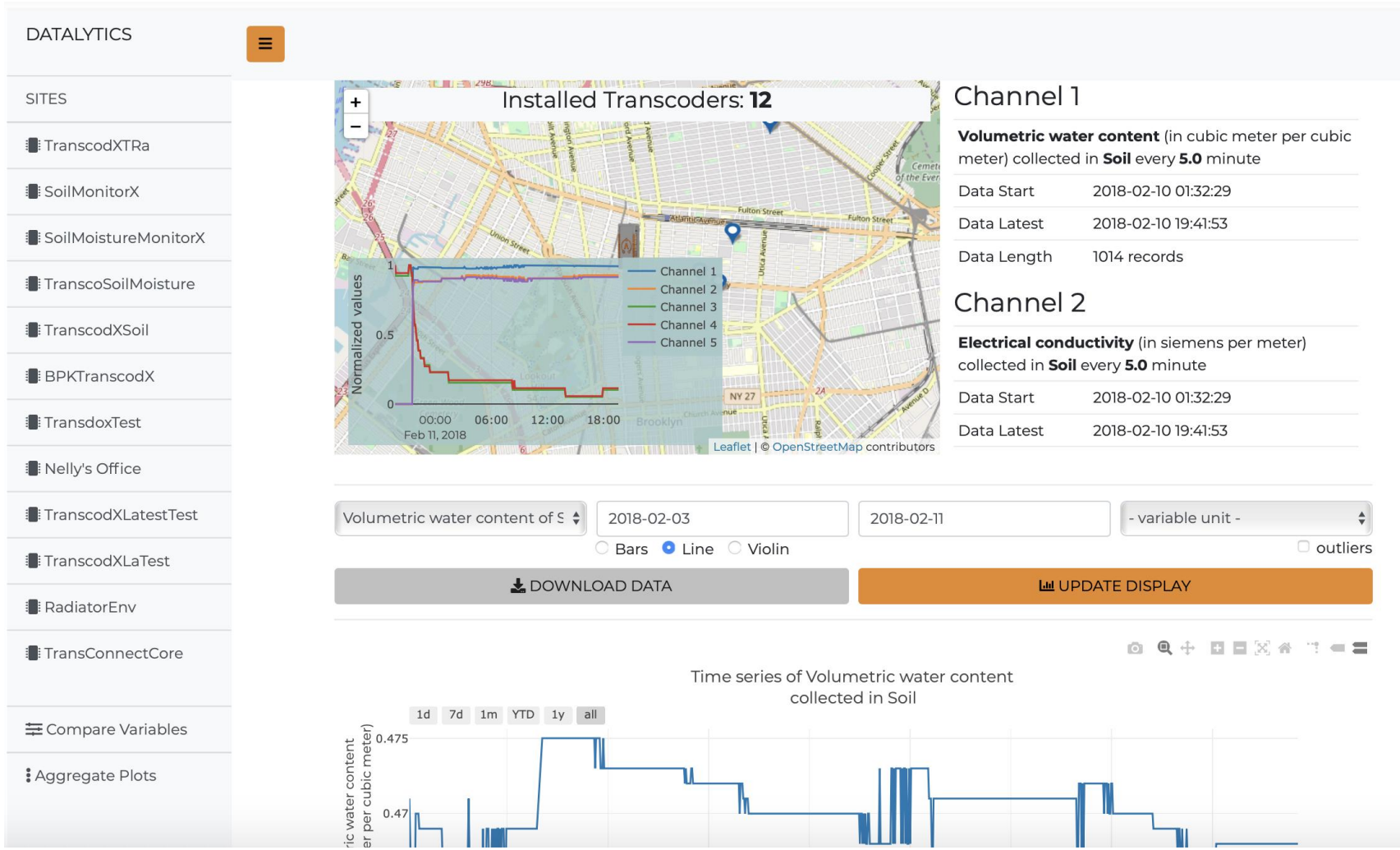
ISDMS: Software Framework – Cont'd

Datalytics: a suite of tools for data analysis and visualization



Beta Testing (Ongoing …)

4 U.S. Universities deploying 5 stations

Thank You!

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