

Modular Ocean Instrumentation System (MOISyT)



System Overview and Deployment Update

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Offshore Wind and Ocean
Power Systems

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ENGINEERING SERVICE CENTER



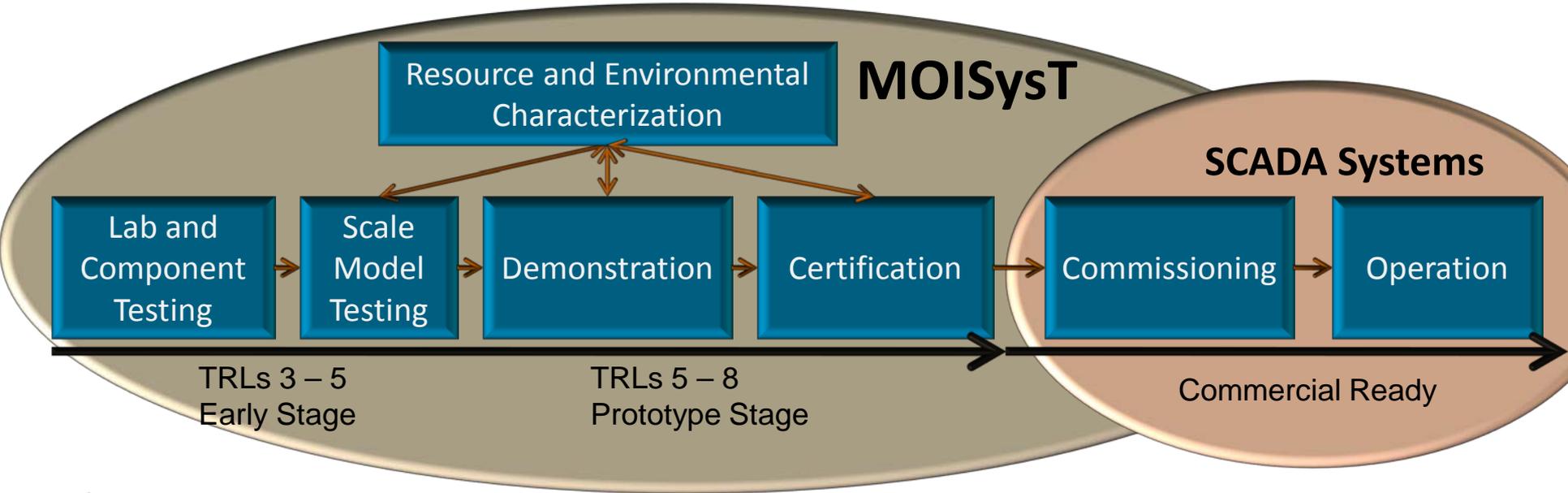
Pacific Northwest
NATIONAL LABORATORY

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An Integrated Instrumentation System to Support MHK Testing

Motivation: To develop a turn-key instrumentation system solution that enables a comprehensive set of measurements for testing of Marine Energy Systems through all TRLs – no such Commercial-Off-The-Shelf system exists



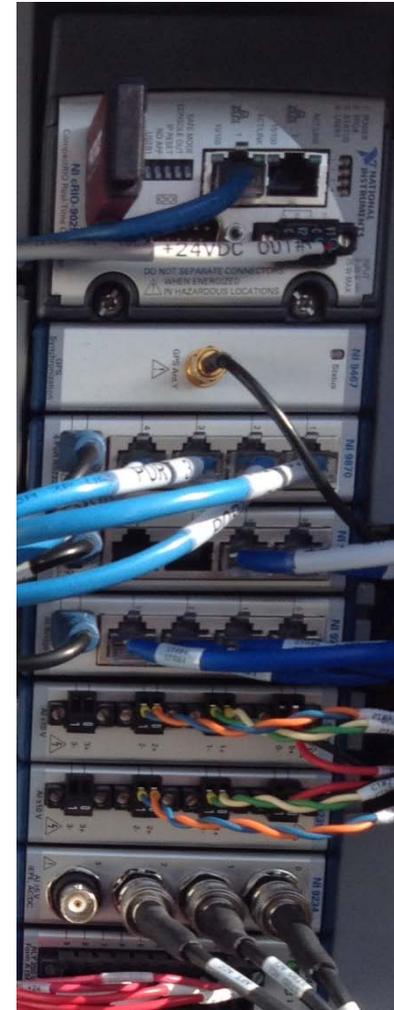
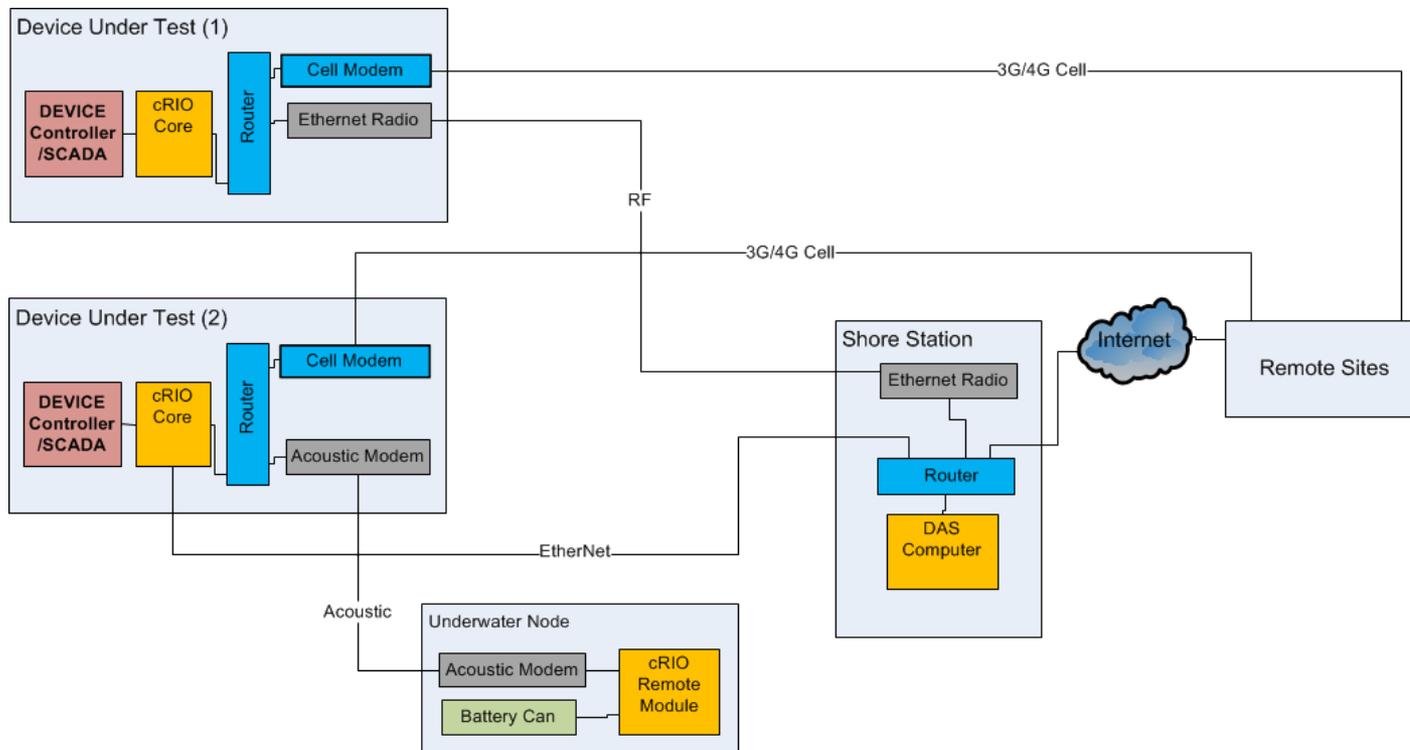
Roles:

- Laboratory and field testing
- Performance and operations monitoring
- Certification
- Device-to-device interaction

- Resource characterization
- Environmental monitoring
- Data collection for model validation

MOISyT Architecture:

- Built on National Instruments cRIO or PXI controllers and LabVIEW software to ensure compatibility and availability of hardware and software, as well as, supportability, training, and maintenance
- Modular and scalable hardware and software – easily customized
- Designed for both centralized and distributed I/O, processing, and control
- Open source hardware layout and software – just ask and its yours



MOISyT Capabilities:

- Applicable to WEC, tidal, river, current and offshore wind testing
- Reconfigurable, expandable, easy to operate, maintain and modify (LabVIEW)
- Supports both analog sensors and external serial instruments and is custom configurable
- Onboard processing to support power quality (50/60Hz), power performance, and loads based on IEC standards, etc
- Existing suite of drivers to support a wide range of sensors and instruments
- Software functions evolving to include remote administration, data visualization, schedulers, error handling, sensor/instrument monitoring, on-the-fly configuration, data formatting, event monitoring, adaptive sampling, and coordinated data storage
- Integrated GPS based timing for tight time synchronization between instruments and multiple MOISyT systems

Supervisory Computer

- Administration and configuration
- Data processing and storage
- Streams data to external sites

Device

- Power quality and performance
- Loads
- Stability and response
- System health and status

Surface Buoy

- Wind speed and direction
- Current speed and direction
- Wave spectra
- Meteorological conditions

Subsea Node

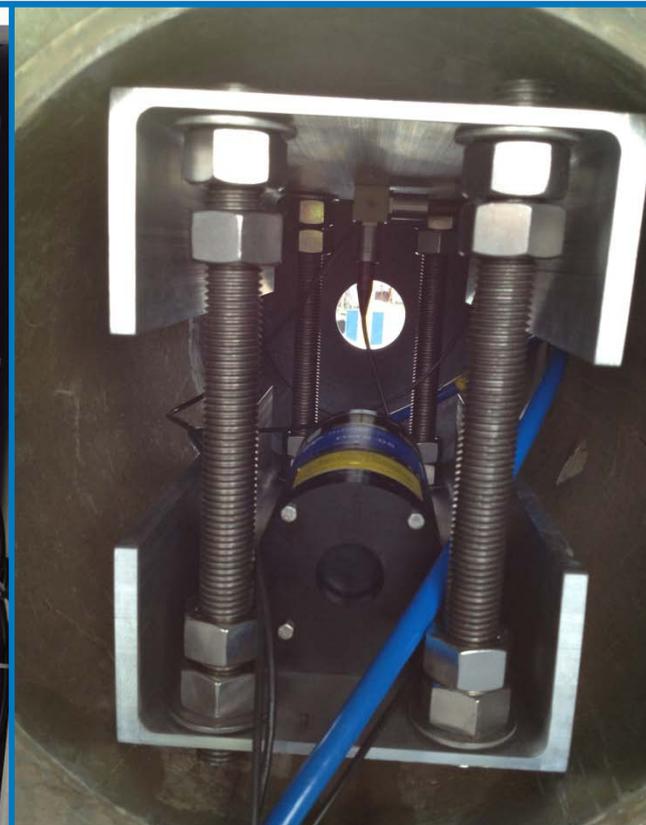
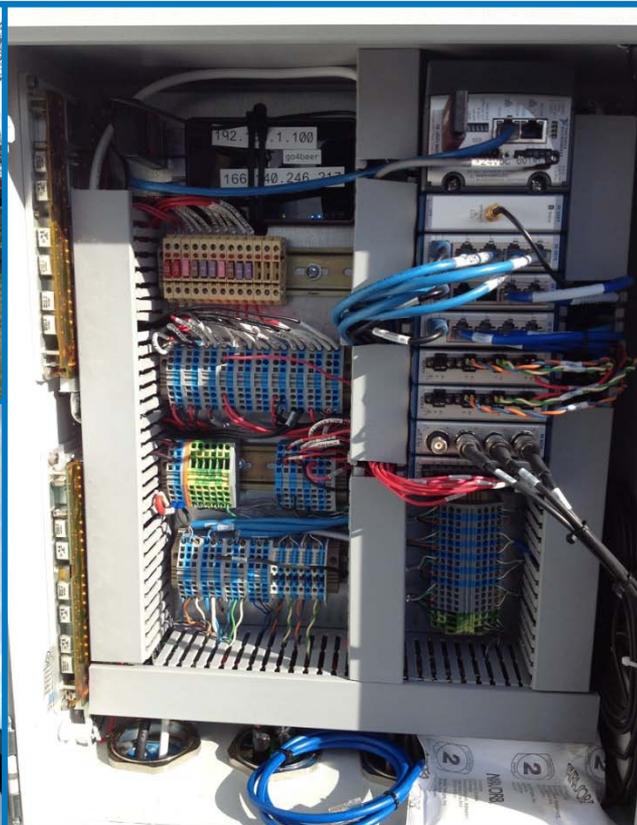
- Current speed and direction
- Wave spectra
- Water Properties
- Noise



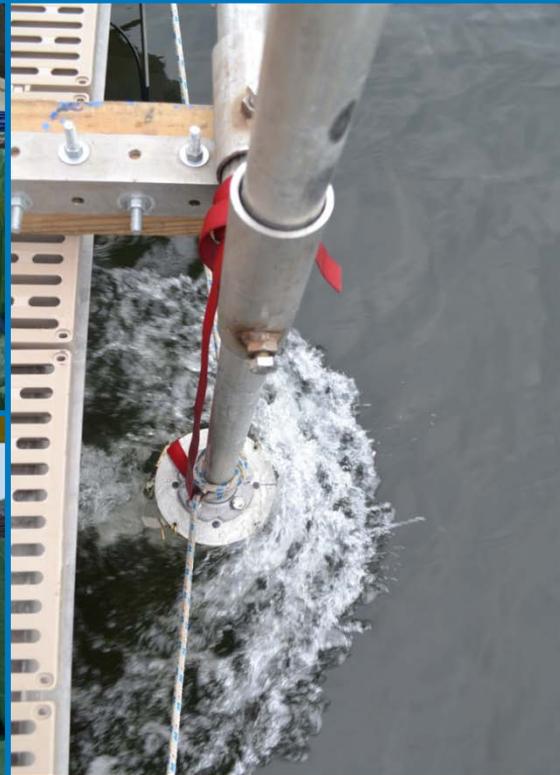
MOISyT External Instruments Supported, so far...

Device Type (Purpose)	Manufacturer	Communication
AWAC (Wave Measurement)	Nortek AS	RS-422 Serial
Vector ADV(3D water current vel.)	Nortek AS	RS-232 Serial
DMS-05 (6DOF motion)	Teledyne TSS	RS-232 Serial
V101 (GPS Based Compass)	Hemisphere	RS-232 Serial
Ultrasonic Anemometer (3D wind)	Applied Technologies, Inc	RS-422 Serial
PSA916 (Depth Sounder)	Teledyne Benthos	RS-232 Serial
MTI-G (MEMS 6DOF motion)	XSENS	RS-232 Serial
Bachmann MPC200(Device Controller)	Bachmann	CAN (Devicenet)

Field operations in MHK and offshore deployments – FFP Deployment



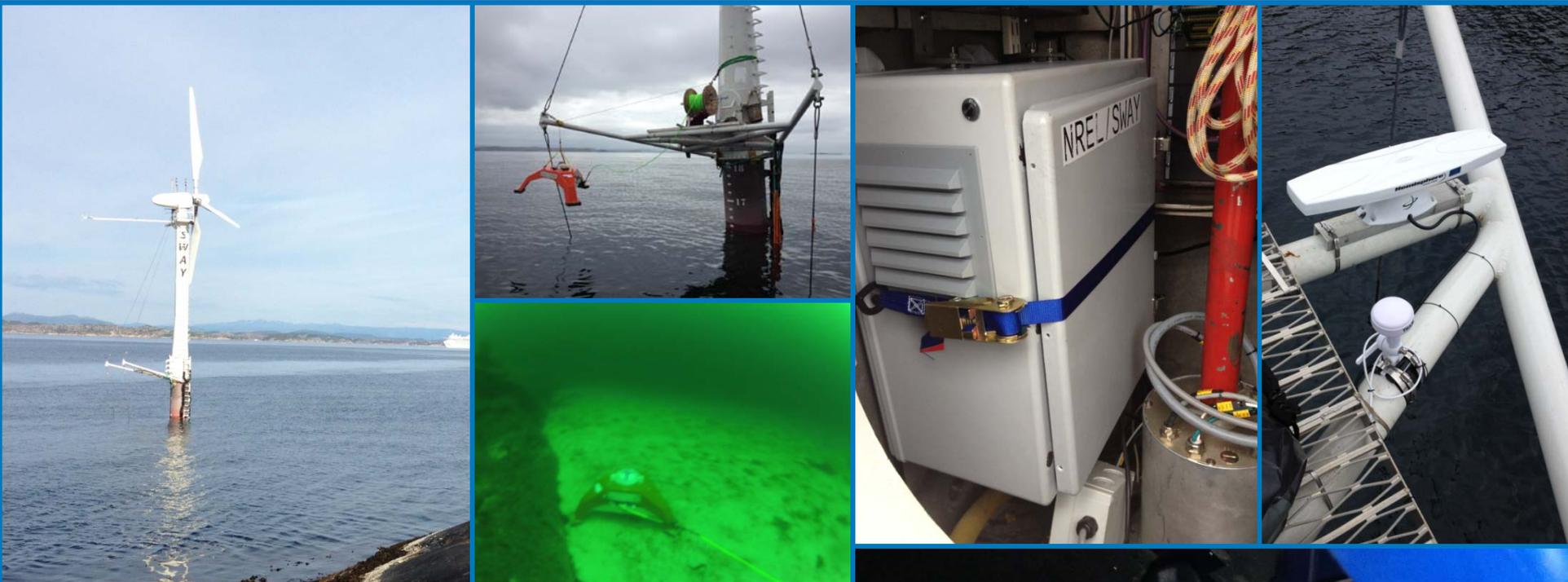
Field operations in MHK and offshore deployments – UNH Deployment



NREL operated, May testing
Client Operated – June / July



Field operations in MHK and offshore deployments – SWAY Deployment



SWAY Status UI Screenshot

Serial Instrument Output

Sonic 1 (Boom)
U 00.00 V 00.01 W 00.00 T 23.62 X -176 Y 15 Z -177 Tw 23.27 Tw 88.49 Tw 23.62

Sonic 2 (Platform)
U 00.01 V 00.02 W 00.00 T 22.87

V010
SGPGGA,8.20738,0.3954,8.002154,N,105.13,5.828823,W,2.05,2.9,1852.4,M,-20.8,M,7.0,0.0,0.0

DMS
:0010 8996 0000 00000 00000-0020-0003-0003 09788 00012 00009 U
5517 2410 0003 0001

MTI-G
Ax -0.23 Ay 0.06 Az 0.84 Gx 0.01 Gy 0.00 Gz -0.00 R 0.40 P 0.01 Y -87.04 Vx -0.02 Vy -0.10 Vw 0.10 Vx Self Test Pass. XXX Valid GPS Fix. 15:07:45 05/25/2012

Wind Turbine Controller Variables

LoadsTowerBm1	LoadsTowerBm2	OutsideAirPressure	OutsideAirTemperature	Pitch1Position	Pitch2Position	Pitch3Position
11.00026.0000	11.00026.0000	11.00026.0000	11.00026.0000	11.00026.0000	11.00026.0000	11.00026.0000

Channel View

| Data Folder |
|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| C:\Data\GPS | C:\Data\DMS | C:\Data\SONIC_1 | C:\Data\SONIC_2 | C:\Data\WTC | C:\Data\MTI-G |
| Number of Data Files |
| 73 | 75 | 132 | 13 | 100 | 32 |

Instrument Error Indicators

Sonic 1 Error	Sonic 2 Error	V010 Error	DMS Error	WTC Var Error	GPS Error	MTI-G Error
status_code	status_code	status_code	status_code	status_code	status_code	status_code
0	0	1073076294	0	0	0	1073076294
source	source	source	source	source	source	source
		VISA Read in Serial IO Incessant Flush				VISA Read in ReadMTI-G via -MTI-G



MOISyt Deployment Lessons Learned, so far...

Concern	Solution	Challenges
System should capture unexpected events	Run the system 24/7, battery backup system if shore powered. FPGA watchdog of real-time software	Lots of data (1GB per day at SWAY AS)
Data files for each measurement makes cross comparing channels tedious	Data viewer to load multiple measurement files and overlay plots	Quick-look tool may be inadequate
System requires operator interactions daily	Automate as much as possible both downloading of data and health of system	Takes leap of faith. Data arriving?
Relying on remote site internet access	Weeks long site evaluation of data throughput to determine suitability	Time and expense
LabVIEW TDMS files not optimized for string data	Write ASCII text files for RS-232 instrument output	Loss of metadata
Many “new” instruments may comprise overall system	Bench test the system with ALL instruments and sensors installed	Time and expense

Thank you!

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