National Ecological Observatory Network

Project Overview
and
Aquatic Science

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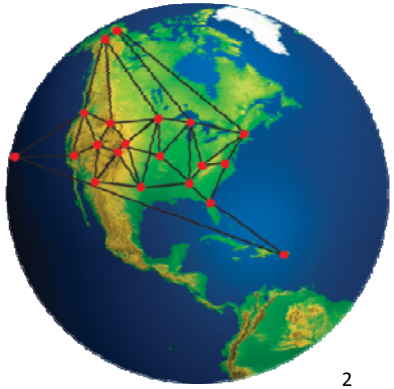
NEON Goals

Enable understanding and forecasting of climate change, land use change, and invasive species on continental-scale ecology by providing infrastructure to support research in these areas.

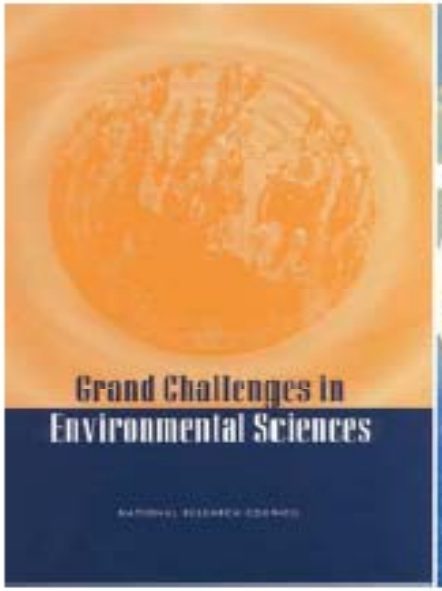
- **Information infrastructure:** Consistent, continental, long-term, multi-scaled data-sets and data products that serve as a context for research and education.

- **Physical Infrastructure:** A research platform for investigator-initiated sensors, observations, and experiments providing physical infrastructure, cyberinfrastructure, human resources and expertise, and program management and coordination.



Grand Challenges in Environmental Sciences

1. Biodiversity
2. Biogeochemical cycles
3. Climate change
4. Ecohydrology
5. Infectious disease
6. Invasive species
7. Land use



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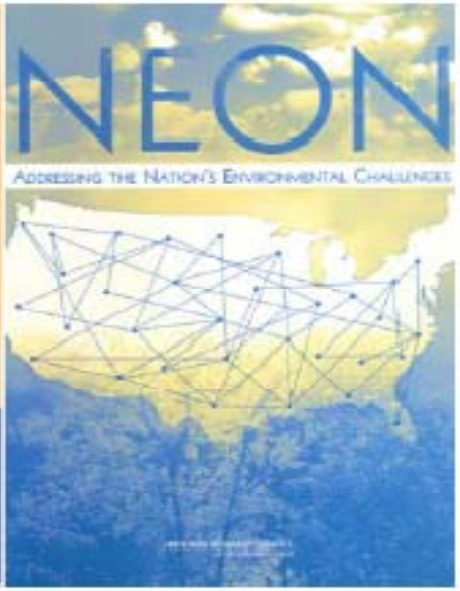

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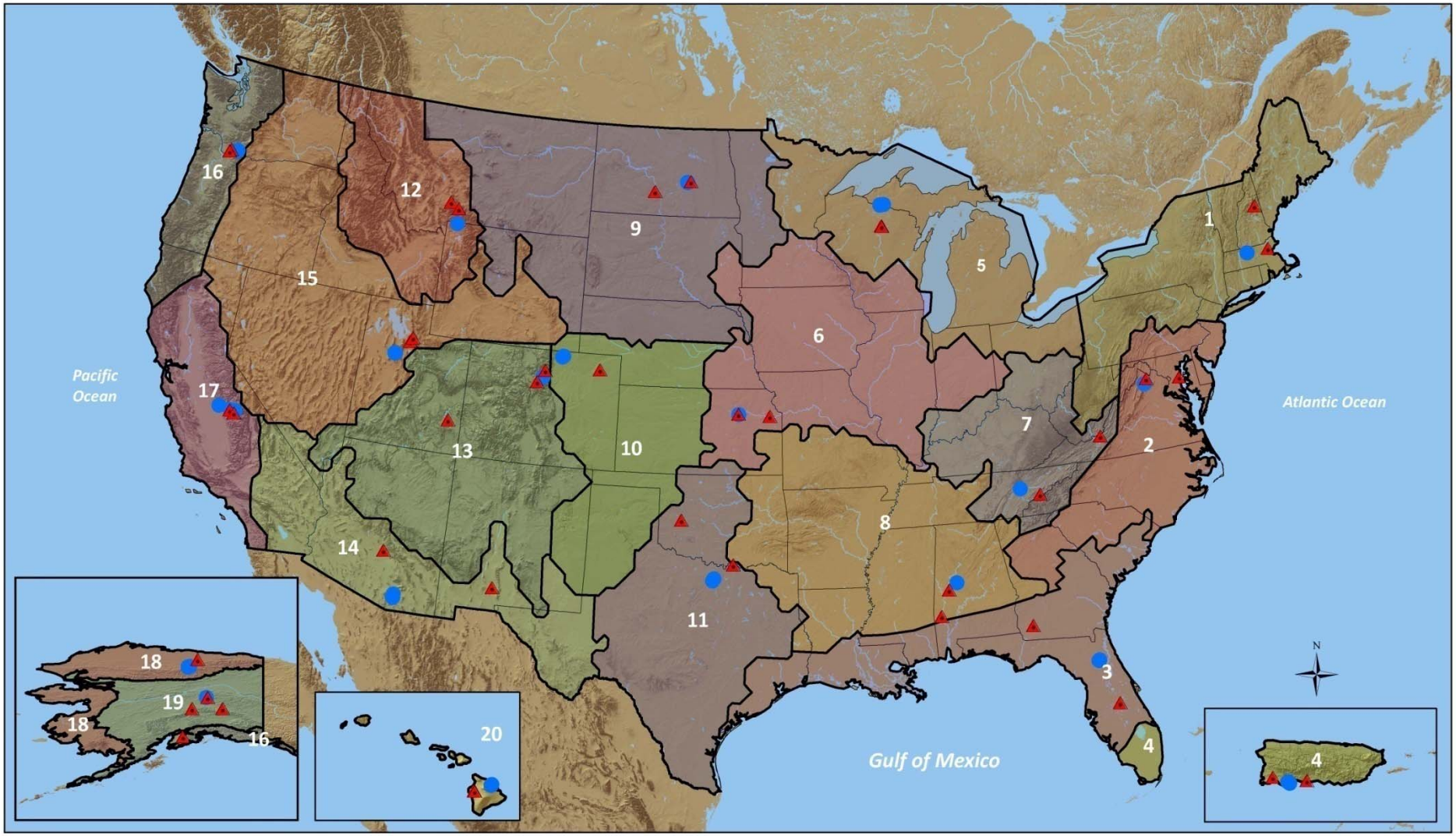


NEON Domains

1 Northeast
2 Mid Atlantic
3 Southeast
4 Atlantic Neotropical
5 Great Lakes
6 Prairie Peninsula
7 Appalachians/Cumberland Plateau
8 Ozarks Complex
9 Northern Plains
10 Central Plains
11 Southern Plains
12 Northern Rockies
13 Southern Rockies/Colorado Plateau
14 Desert Southwest
15 Great Basin
16 Pacific Northwest
17 Pacific Southwest
18 Tundra
19 Taiga
20 Pacific Tropical

GRAND CHALLENGES

Forcing
Climate, Land Use
Invasives

Interactions, Feedbacks
Productivity, Functional Diversity,
Soil Moisture, Habitat Structure, etc.

Responses
Biodiversity, Biogeochemical,
Disease, Ecohydrology

Lead to focused questions that NEON can address on continental scales...

What implications do breeding bird phenological shifts have for West Nile Virus disease risk?

How does the changing pattern of land use affect terrestrial productivity at the continental scale?

What is the aquatic biological response to sustained increases in nutrients?

How are the rates of geographic spread and population growth of invasive species affected by land use and climate change?

That require specific data products to answer the questions...

Bird diversity; West Nile Virus prevalence in mosquitos

Land cover classification; Ecosystem exchange of carbon

Benthic macro-invertebrate diversity and abundance; Stream metabolism

Invasive species risk maps; Historical Climate Data

And NEON's infrastructure supports science packages that provide the measurements required to produce the data products

FSU	FIU	AOP	LUAP	STREON	+...
Science Reqs	Science Reqs	Science Reqs	Science Reqs	Science Reqs	
Tech/Ops Reqs	Tech/Ops Reqs	Tech/Ops Reqs	Tech/Ops Reqs	Tech/Ops Reqs	

NEON Science Subsystems

FSU:	**Fundamental Sentinel Unit**	**Human Observers/Samplers**
FIU:	**Fundamental Instrument Unit**	**Automated Instrumentation**
AOP:	**Airborne Observation Platform**	**Aircraft Remote Sensing**
LUAP:	**Land Use Analysis Package**	**Satellite Remote Sensing +**
AQU:	**Aquatic/STREON**	**Instr. + field sampling**

+ **Education mission**: Prepare society/scientific community to use NEON data, information, forecasts…

Level 1 Data Product Deliverables (Total = 539)

Science Sub-System	Level 1 Products	Examples
FSU	200	Species ID, number of individuals, Hantavirus presence, tree diameter, leaf N concentration
AQU/STR	194	Algal cell count, macroinvertebrate biovolume, stream discharge
FIU	100	Temperature, humidity, PAR
AOP	4	Spectral reflectance, vertical waveform
LUAP (Level 3)	41	Topography, satellite spectral reflectance, human population density
TOTAL	539	

Level 4 Data Product Deliverables (Total = 118)

Suite	Level 4 Products	Examples
Bioclimate	18	Climate forcings, LAI, fPAR
Biodiversity	31	Abundance, diversity, phenology, demography
Biogeochemistry	30	Ecosystem-atmosphere exchange, nutrient stocks and fluxes
Ecohydrology	10	Soil moisture, water-balance, stream discharge
Infectious Disease	7	Disease prevalence (WNV, Lyme, dengue)
Land Use Change	22	Environmental properties, land cover, land use

AQU: Forcing Variables

Morphology

Riparian Canopy

Surface and ground water

- major cations & anions
- isotopes (C, N, P, O)
- nutrients
- temperature
- oxygen
- pH, conductivity
- Turbidity, cDOM
- stream discharge
- water height

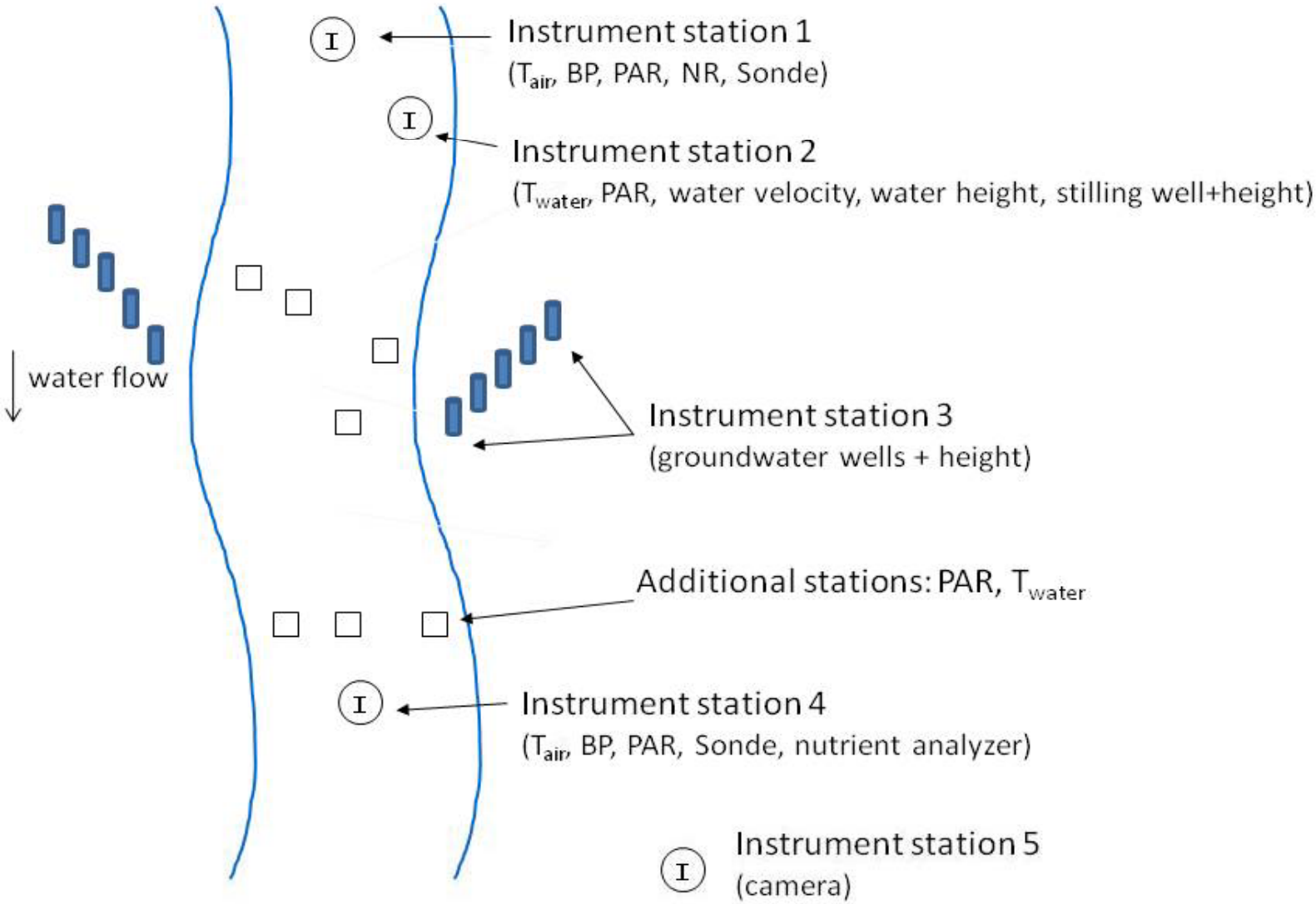
Terrestrial environment

- temperature
- barometric pressure
- PAR
- net radiation
- wind speed

AQU: Response Variables

	Biodiversity & Invasive species	Microbial Diversity & Function	Biogeochemistry & Productivity	Ecohydrology	Infectious Disease
Fish	X			X	
Invertebrates	X		X	X	
Aquatic Plants	X		X	X	
Algae	X	X	X	X	
Water		X	X	X	
Sediment/ detritus		X	X	X	
Plants	X	X	X		
Mosquitoes	X				X

Instrument Installation - Example

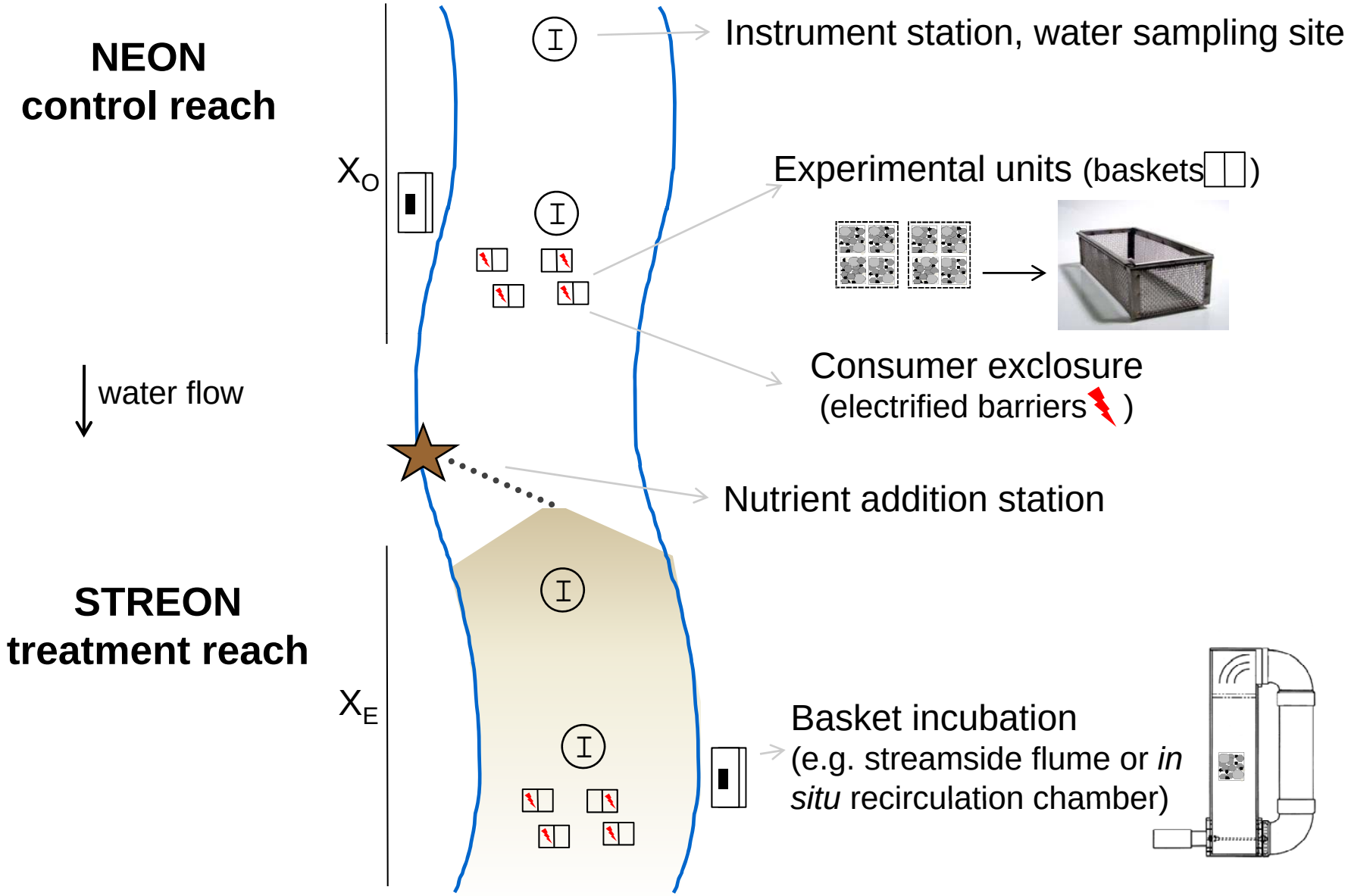


COTS Instruments

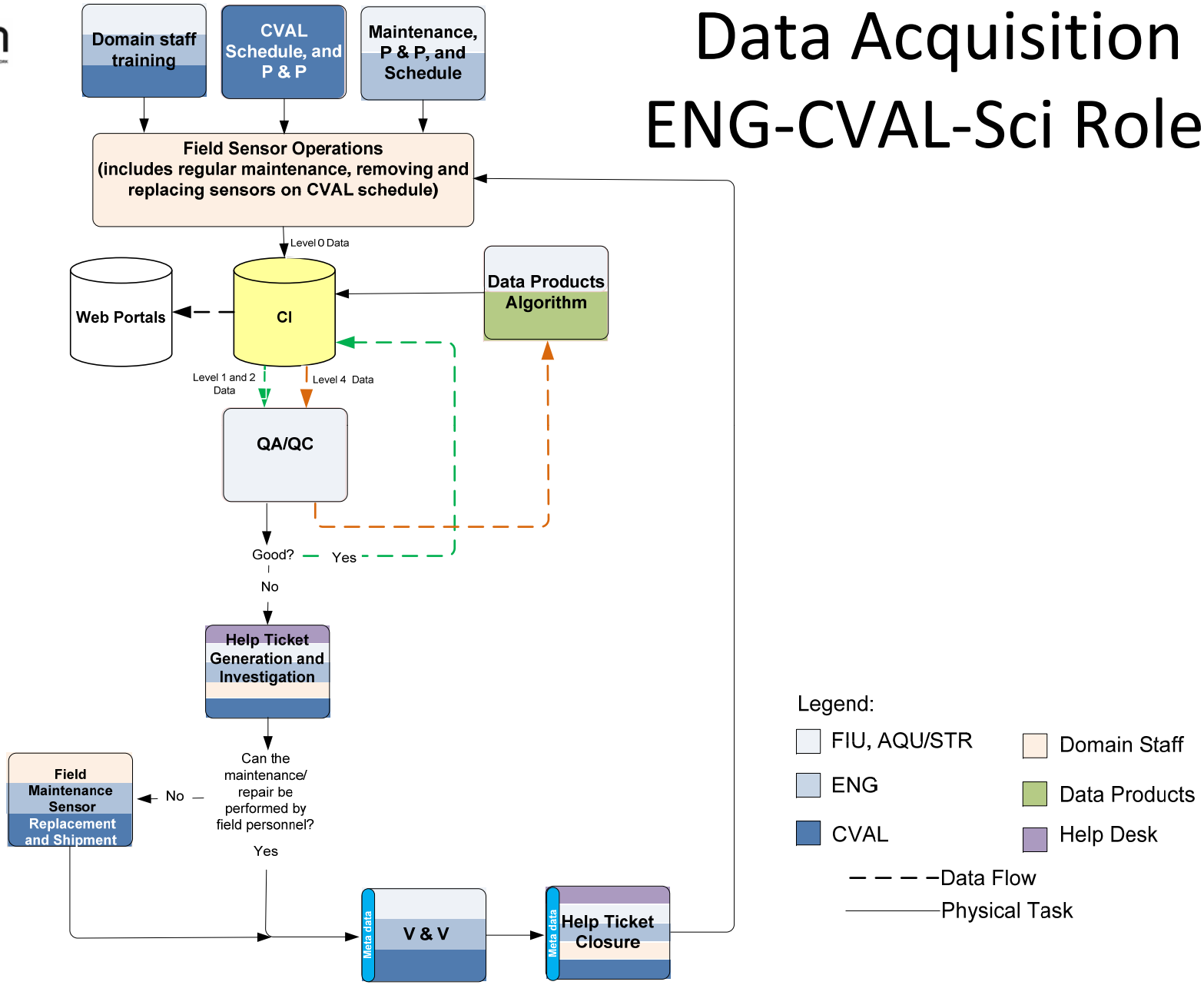
Multi-parameter Sondes

Nutrient analyzer

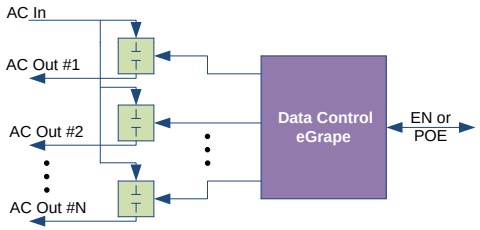
NEON Experiment – STREON (10 sites)



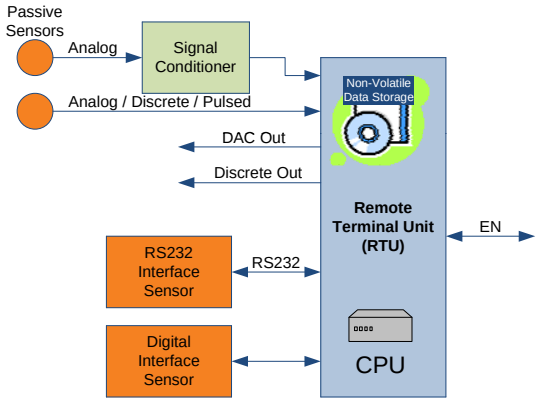
Data Acquisition
ENG-CVAL-Sci Roles



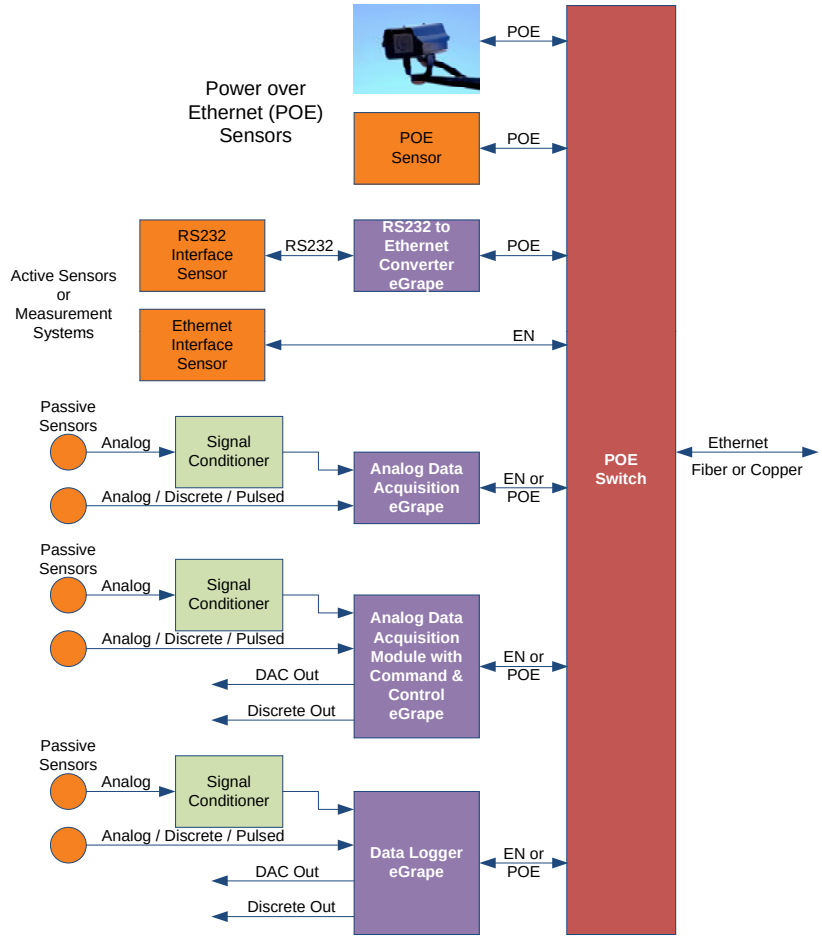
Data Acquisition - eVINE



Power Distribution (ePOD) Module provides remote switching of AC Power



RTU is a computer with local storage capable of optional direct interface with a variety of sensors and provide direct command and control capability



Sensor ***eBunch*** consists of one or more sensors connected directly or through an ***eGrape*** to a single Power over Ethernet Switch (POE)

eVINE Approach

- Highly flexible sensor interface that uses industry standard equipment

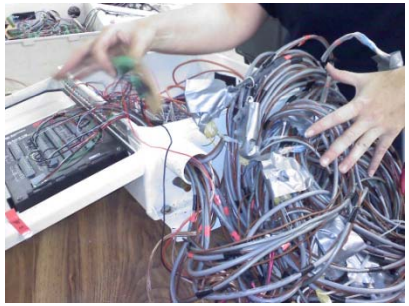
- Managed Power over Ethernet (PoE) network.
  Distributes standard 48 volt DC power on signal cables, reduce connections.
  Remote monitoring and control with PoE switches, SNMP and interface web pages.
  Uses industry standard Ethernet components.

- Locate data acquisition (eGRAPEs) close to the sensor to minimize cable lengths and noise, and transmit data in digital format.
  Allows the serialization of multiple inputs and outputs over a standard Ethernet connection.

- eGRAPEs can be:
  Ethernet-enabled instruments.
  Serial to Ethernet converters.
  Commercial low cost industrial data acquisition systems.
  Data loggers from Campbell and other third parties.
  NEON custom designs with high stability references and converters.

Benefits to eVINE

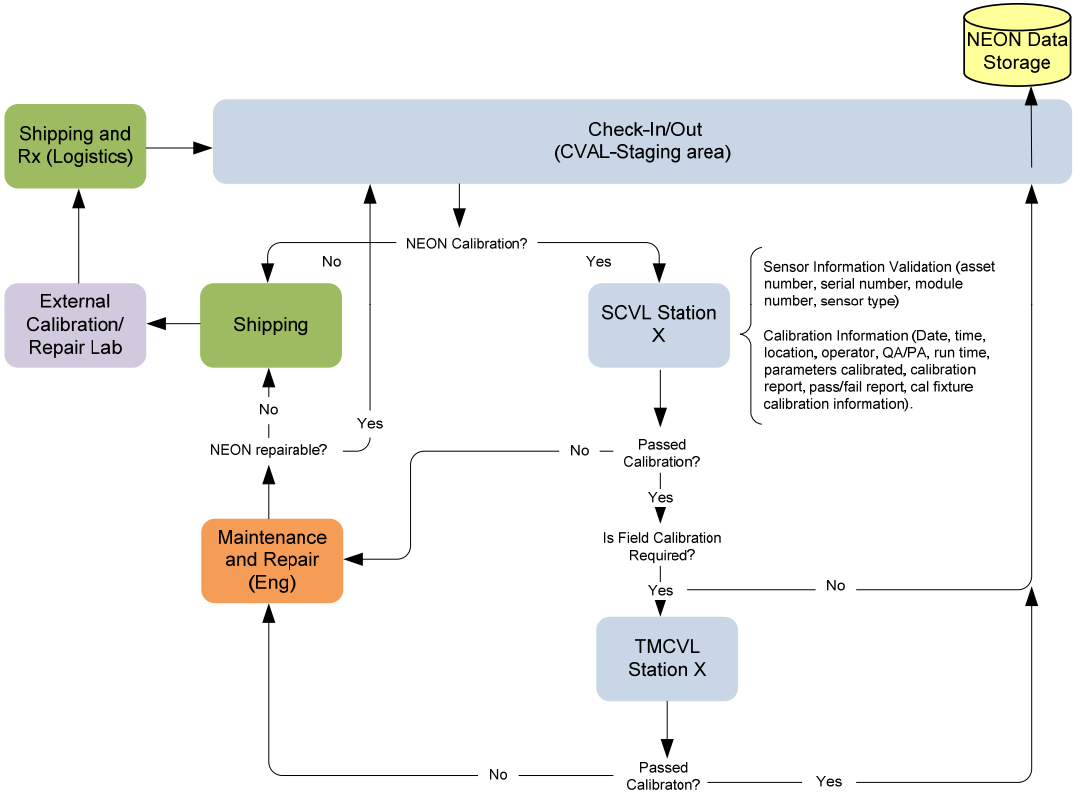
- Ethernet-enabled and PoE instruments directly supported.
- Much simpler cabling system.
- Eliminates specialized cables and connectors, reduces cost and unique part numbers.
- Lower cost overall cost than traditional remote data acquisition approaches
- Allows remote control and management of data acquisition.
- PoE DC power distribution reduces main power wiring, saves installation costs and increases safety.
- High state of health monitoring visibility
- Managed switches provide measurements of voltage and current as well as the capability to remotely power devices off/on.
- Measure resistance and return resistance to 1 micro ohm resolution.
  - Required resolution is 10 micro ohm for 0.01 deg C.
- Use precision reference current of 1 mA, with ability to turn on and off.
- 3 PPM/Deg C reference and 24 bit converter, with integral 60 Hertz rejection.



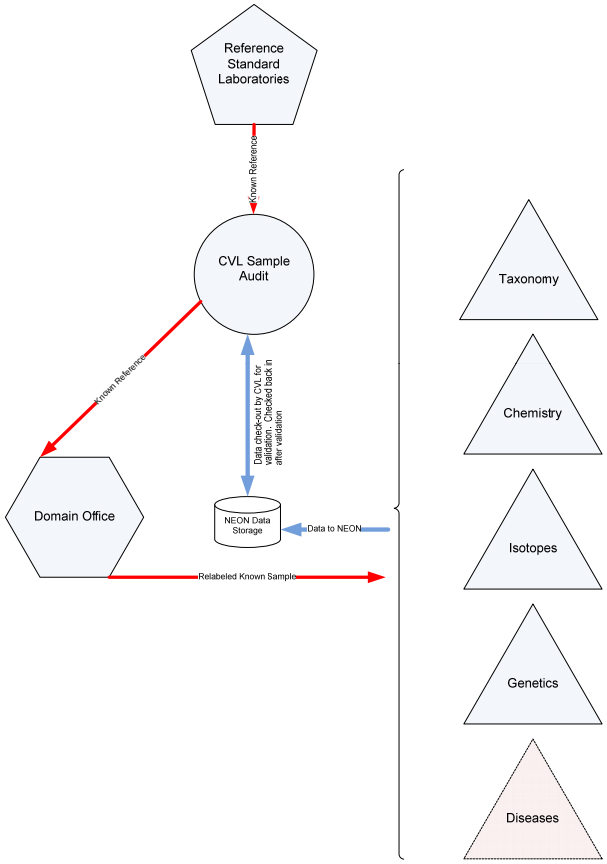
Data Acquisition - ENG

- RTU features:
  - RTUs provide a standard interface between locations and NEON HQ
  - Remote Terminal Units (RTUs) are local computers that provide:
    - Communication and command & control interface to non-analog sensors
    - Local processing
    - Timing
    - Local data storage
    - Communication interface with NEON HQ
  - RTU may be placed anywhere on the network
    - RTUs may be added to increase data acquisition reliability
    - Each RTU is assigned specific sensors or eGRAPEs to interface with
  - RTU are either a PC104 or standalone computer running Linux.
    - Data acquisition software is called NIDAS, which was developed by NCAR

CVAL

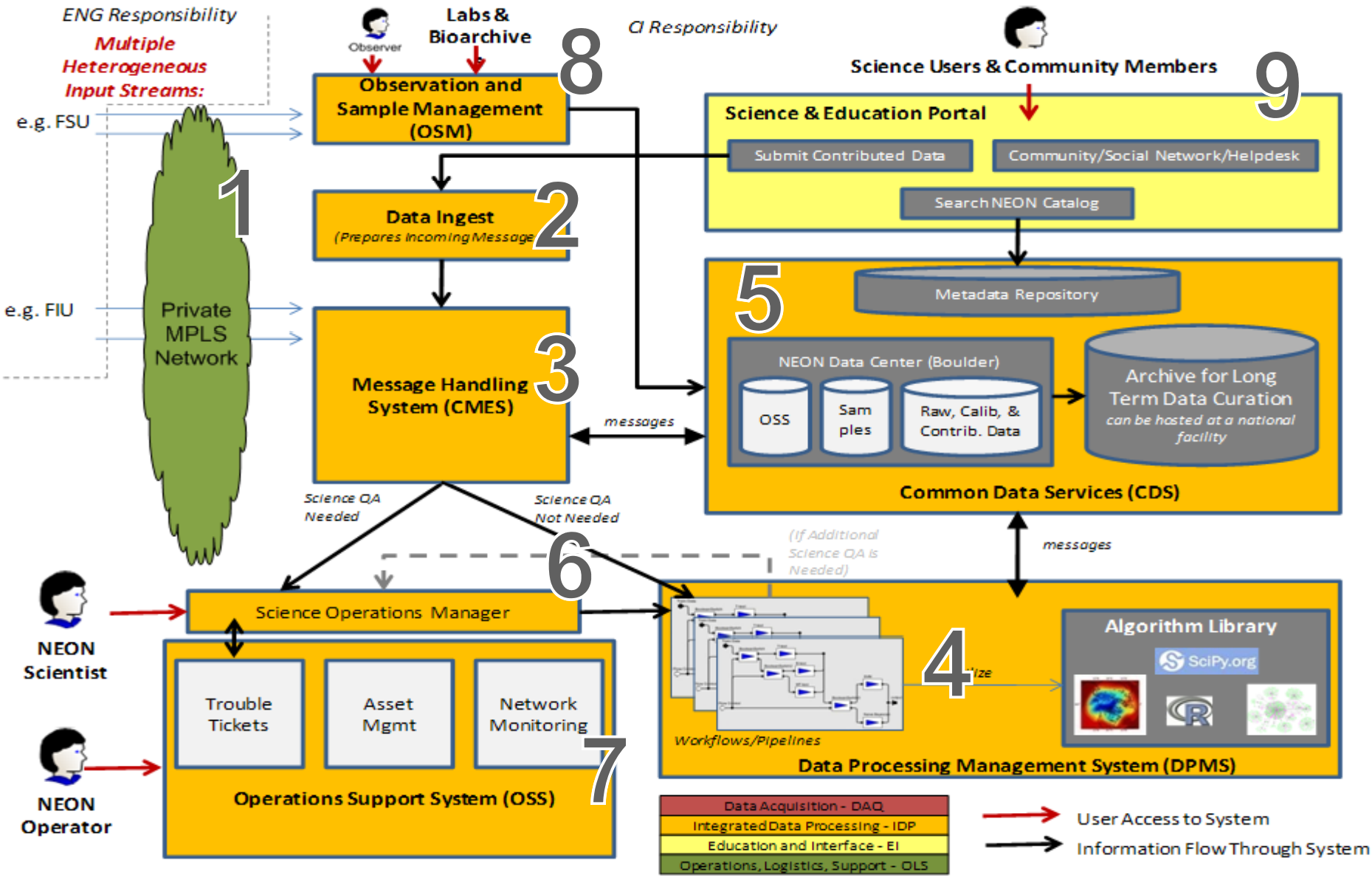


Sensor Flow



Audit Flow

NEON Cyber Infrastructure

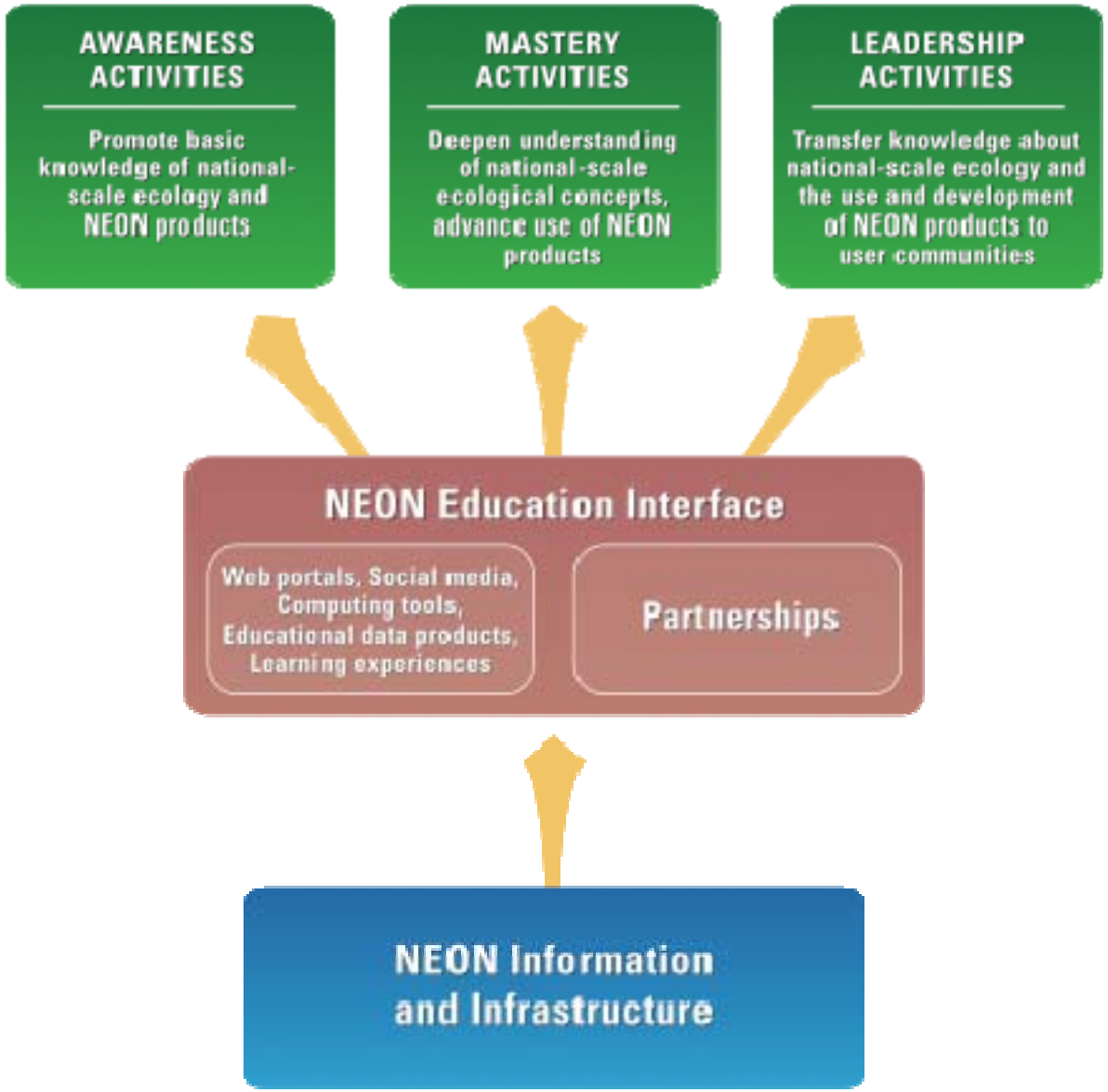


Sample Management - Maximo

Asset Management requirements are the most critical for the OSS and OSM subsystems, and drove the product evaluation process

- Maximo is the recommended solution for Asset Management (AM) and Observation and Sample Management (OSM) because it:
  - Provides a comprehensive suite of configuration, maintenance and management tools aligned with NEON CI requirements
  - Satisfies all required core AM and OSM capabilities
  - Has demonstrated scalability /extensibility
  - Has multiple interface capabilities to other systems (e.g. ERP)
- Maximo will track samples, as well as much of the data related to the samples (measurements, timestamps, etc)

Education


AWARENESS ACTIVITIES
Promote basic knowledge of national-scale ecology and NEON products
MASTERY ACTIVITIES
Deepen understanding of national-scale ecological concepts, advance use of NEON products
LEADERSHIP ACTIVITIES
Transfer knowledge about national-scale ecology and the use and development of NEON products to user communities
NEON Education Interface
Web portals, Social media, Computing tools, Educational data products, Learning experiences
Partnerships
NEON Information and Infrastructure

Session Questions

- Where do we need to go (what is needed for instruments, protocols, databases, etc)?
- Why aren't we there? (What are the technological and other impediments?)
- How do we fill these gaps to get where we need to go

NATIONAL ECOLOGICAL OBSERVATORY NETWORK

The National Ecological Observatory Network is a project sponsored by the National Science Foundation and managed under cooperative agreement by NEON Inc.