National Ecological Observatory Network

Observatory Design and Requirements

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Intro/Scope

- ## System Definition
  - Observatory Architecture/Design
  - Observatory Interfaces (Inter-Segment and Inter-Element)

- ## System Requirements
  - Definition and Development Effort
  - Database/Documentation
  - Current Requirements Summary
  - SRR Out-brief

National Ecological Observatory Network

System Definition

System Definition

- The NEON System is unique…
  - A large scale collaboration of physical hardware, software, people and management
  - It must be operated and maintained for a planned 30 year life-time while the scientific community plays an active role in driving its data acquisition techniques and overall observing strategy
- The System design outlined herein breaks out actual system functions and deliverables into dedicated elements and allocates them across segments
  - This systems engineering approach is necessary for capturing, defining, and allocating requirements appropriately to the lower level sub-systems and components of NEON
  - Provides a high-level view of the overall system design, without impacting the lower level designs
  - Outlines system boundaries $\Rightarrow$ Interfaces

NEON System Design

NEON System Design

DAQ – Data Acquisition

AOP	FI	FSU	AQU
1.RSP (Spectrometer, waveform altimeter LIDAR, high-res digital camera, GPS/IMU) 2. Aircraft Platform 3. Flight Operations	1. FIU (Tower, Instrumentation Hut, Soil, Field) 2. MDP	1. FTC (Field Teams) 2. Bioarchive	1. FTC (Field Teams) 2. Bioarchive 3. STREON

IDP – Integrated Data Processing

DRR	DPM	DSS	OSS
1. CMES 2. Data Ingest (DAQ Subsystems, LUAP, Community) 3. DSM	1. DPMS 2. Definition Repository 3. CAS 4. DQM	1. CDS 2. Raw Data Repository 3. Processed Data Repository 4 Data Archive	1. PTR 2. AM 3. Monitoring 4. SOM

EI – Education and Interface

Web Portal	Education and Outreach
1. Interface 2. Data Publishing	1. Research, Learning and Training 2. Partnerships 3. Tools

OLS – Operations, Logistics and Supportability

NI	NMC	Technical Facilities	Support Facilities
1. Data Networks 2. Computing Systems (Hardware and OS) 3. ENMS	1. NEON Control Center (Admin, operations, etc.) 2. Helpdesk 3. Educational Facilities	1. Assy Fab Lab 2. Repair Center 3. Eng Dev Lab 4. Mobile Field Eval Lab 5. FIU Advanced Development and Training Facility 6. AQU Advanced Development and Training Facility 7. AOP Calibration Lab 8. AOP Sensor Tech Facility 9. CAL/VAL Sensor Cal Lab 10. CAL/VAL Sample Audit Lab 11. CAL/VAL Table Mountain Field Sensor Cal Lab	1. Domain Offices 2. FSU Labs

SDPM – Science and Data Products Management

CAL/VAL	Data Products
1. Sensors and Instrumentation (Level 0 Data quality)	1. Algorithm Design and Maintenance (Level 1-4 Data Products quality) 2. Validation and Improvement 3. Development

System Segments
DAQ – Data Acquisition
IDP – Integrated Data Processing
EI – Education and Interface
OLS – Operations, Logistics and Supportability
SDPM – Science and Data Products Management
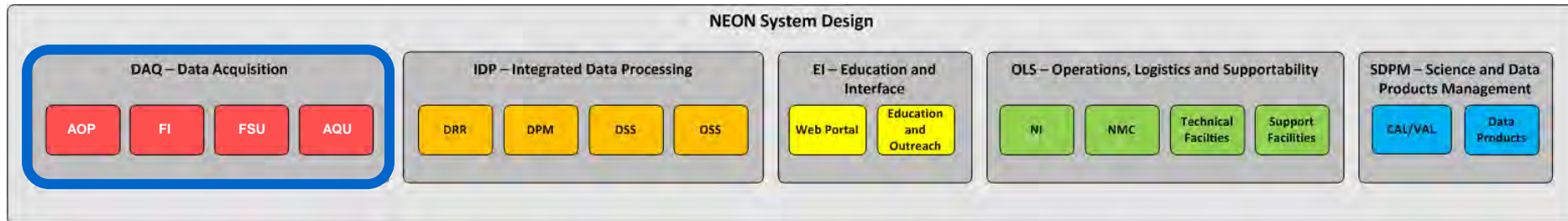
System Elements
AOP – Airborne Observation Platform
AQU – Aquatic
CAL/VAL – Calibration and Validation
DP – Data Products
DPM – Data Processing and Manufacturing
DRR – Data Receiving and Routing
DSS – Data Storage System
EO – Education and Outreach
FI – Field Instrumentation
FSU – Fundamental Sentinel Unit
NI – Networks and Infrastructure
NMC – NEON Management Center
OSS – Operational Support System
SF – Support Facilities
TF – Technical Facilities
WP – Web Portal

Sub-Systems
AM – Asset Management
CAS – Common Application Service
CDS – Common Data Services
CMES – Common Message and Event System
DPMS – Data Processing Management System
DQM – Data Quality Management
ENMS – Enterprise Network Management System
FIU – Fundamental Instrument Unit
FTC – Field Team Component
GPS/IMU – Global Positioning System / Inertial Measurement Unit
LUAP – Land Use Analysis Package
MDP – Mobile Deployment Platforms
OSM – Observation and Sample Management
PTR – Problem Tracking and Reporting
RSP – Remote Sensing Payload
SOM – Science Operations Manager
STREON – Stream Experimental Observatory Network

- ## The NEON System has 5 segments:
  - The DAQ, IDP and EI segments make up the primary system functions and deliverables for acquiring, manufacturing, and providing the overall data products
  - The OLS and SDPM segments provide the overall infrastructure for operations and management of the system

Data Acquisition (DAQ)

NEON System Design

- **DAQ – Data Acquisition:** AOP, FI, FSU, AQU
- **IDP – Integrated Data Processing:** DRR, DPM, DSS, OSS
- **EI – Education and Interface:** Web Portal, Education and Outreach
- **OLS – Operations, Logistics and Supportability:** NI, NMC, Technical Facilities, Support Facilities
- **SDPM – Science and Data Products Management:** CAL/VAL, Data Products

- Contains the elements and sub-systems that provide the necessary functions for acquiring Level 0 data within the ecological environments of the observatory
  - Airborne Observations (AOP)
  - Field Instrumentation (FI)
  - Field Sampling (FSU)
  - Aquatic Systems (AQU)
- Element designs in DAQ are based on the overall system measurement and observing strategies
- To satisfy the System's spatial observing design for continental scale representation, the DAQ infrastructure will be distributed across 20 total domains where each domain contains a core site and two relocatable sites

Integrated Data Processing (IDP)
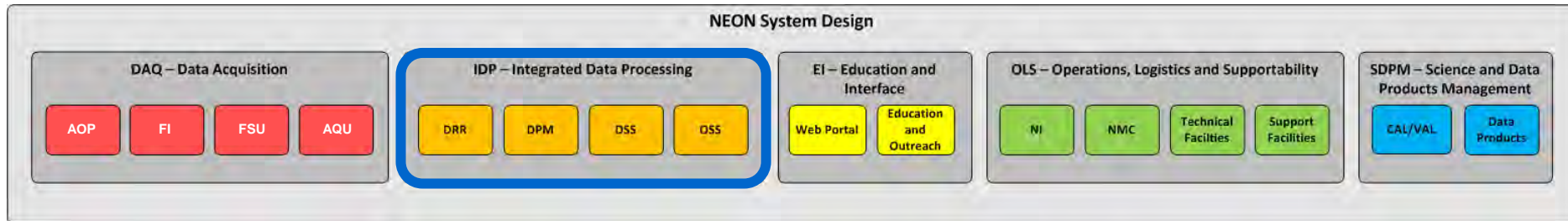
- Contains the elements and sub-systems necessary to route, receive, ingest and process Level 0 and Level 1 data for manufacturing and delivering the observatory data products
  - Data Receiving and Routing (DRR)
  - Data Processing and Manufacturing (DPM)
  - Data Storage System (DSS)
  - Operational Support System (OSS)

- The IDP segment will be located and distributed within the NEON Management Center (NEON Headquarters in Boulder)

Education and Interface (EI)
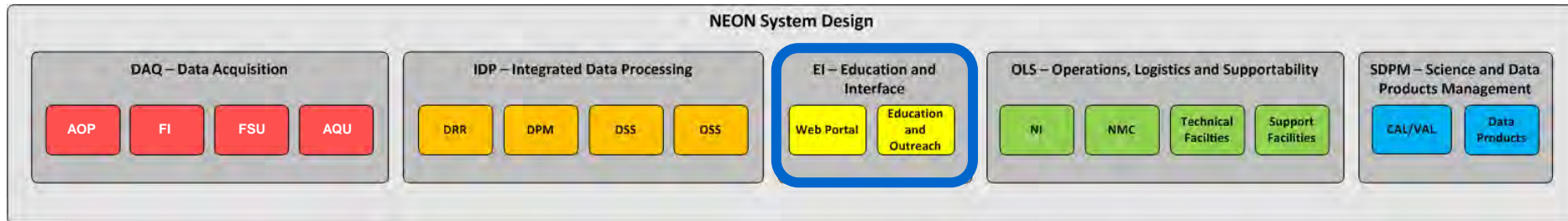
- Contains the elements and sub-system functions to allow accessibility and sharing of the System's data products while providing appropriate resources to facilitate educational programs
  - Web Portal (WP)
  - Education and Outreach (E&O)

- The EI Segment is the interface into NEON with the tools and resources to promote education and learning within its science areas!

Operations, Logistics and Supportability (OLS)
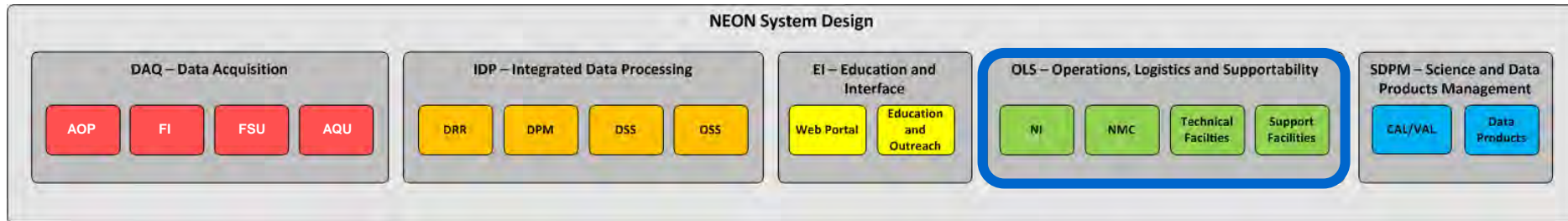
- Contains the elements and sub-systems that provide an overall infrastructure to ensure successful operation and performance of each of the other system segments
  - Networks and Infrastructure (NI)
  - NEON Management Center (NMC)
  - Technical Facilities (TF)
  - Support Facilities (SF)

- OLS Elements are allocated across the entire system and include program administration, facilities and offices, computing resources, physical field structures and non-physical structures (i.e., software and networks)

Science and Data Products Management (SDPM)
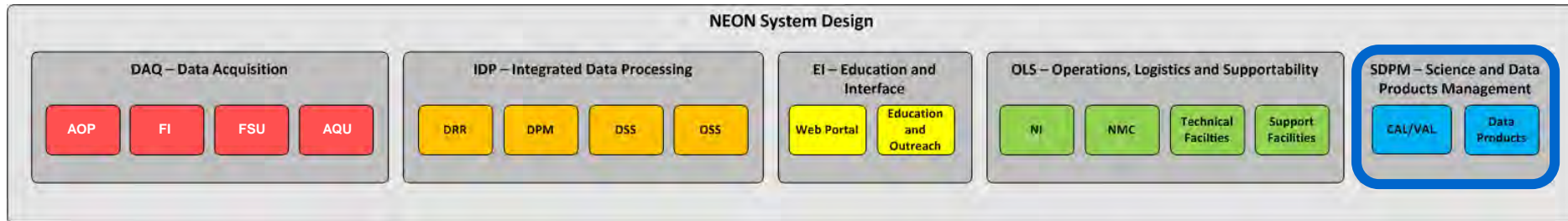
- Contains the elements and sub-system capabilities for controlling data acquisition and processing through pro-active feedback of scientific and engineering expertise
  - Calibration and Validation (CAL/VAL)
  - Data Products (DPS)

- SDPM is primarily a level of effort function that will operate in both the construction and operation phases of the NEON project
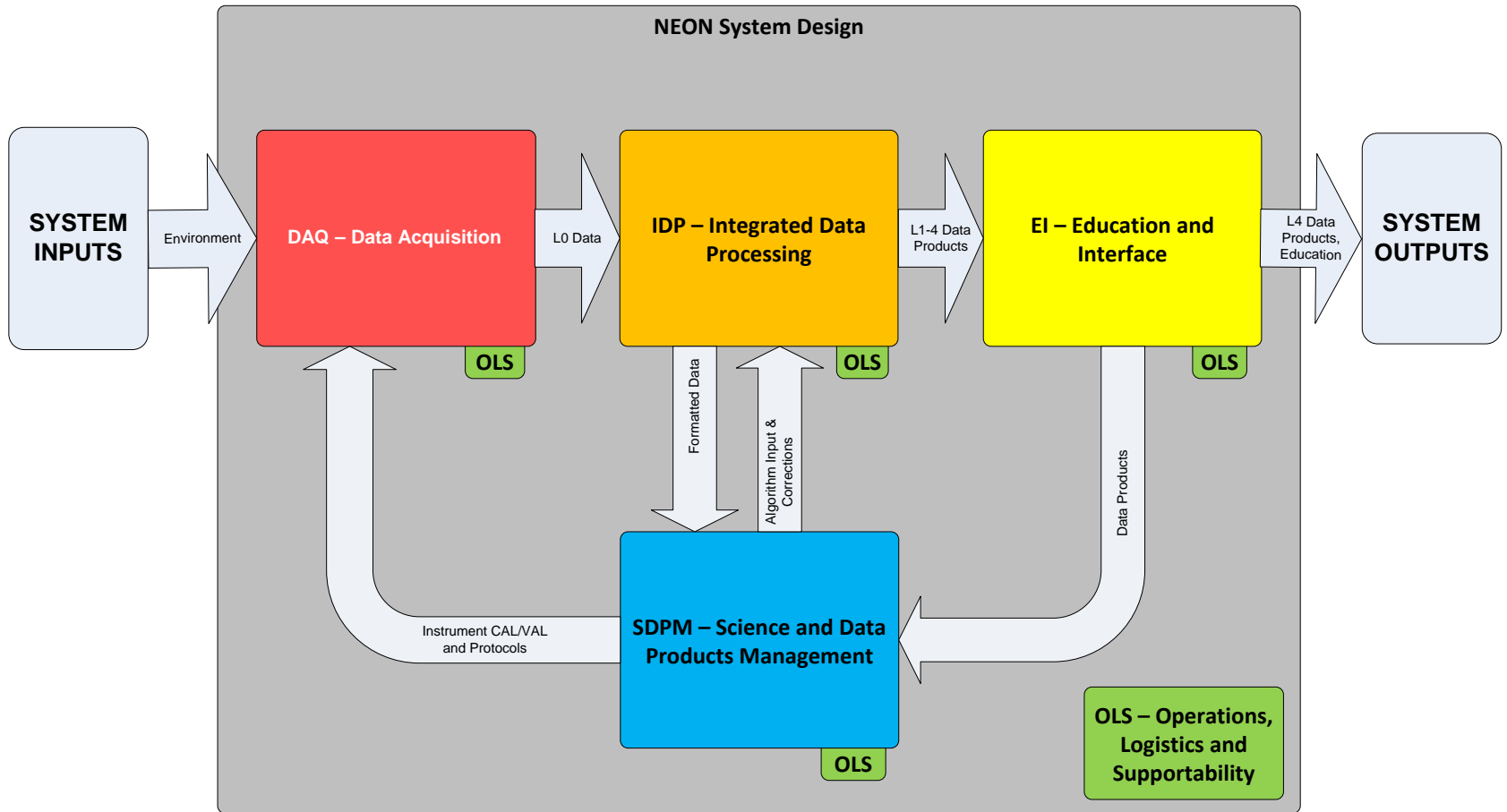
System Interfaces

- The system definition approach of breaking out NEON functions and deliverables into specific segments and elements resulted in both inter-segment and inter-element interfaces
  - At the highest level, the NEON system input and output parameters are the environment and data products, respectively

- DAQ Segment
  - Captures inputs from the environment in the form of ecological drivers and responses; These are then captured in the form of electronically transmissible raw data (Level 0 Data) and transmitted to the IDP segment

- IDP Segment
  - Organizes and processes the Level 0 data to produce the Level 1-4 data products (and stores all Level 0 data and Level 1-4 data products); The IDP segment then provides Level 1-4 data products to the EI segment for external use

- EI Segment
  - The EI segment is the user interface to NEON and will provide the overall system outputs in the form of publicly available data and education/training

System Interfaces

- ## SDPM Segment
  - Provides the feedback mechanisms for ensuring the entire process of producing high level data products from raw ecological variables is valid and accurate
    - Evaluates the Level 4 data products and provides feedback to the computational algorithms in the IDP segment
    - Evaluates Level 0-3 data and data products to provide feedback regarding calibration and validation for sensors and protocols in the DAQ segment

- ## OLS Segment
  - Provides the overall infrastructure to operate the other 4 segments, including offices, facilities and networking
  - Because OLS is defined as the infrastructure to carry out NEON functions, and those functions are captured in the other segments (DAQ, IDP, EI, SDPM), OLS has unique "usage interfaces" to each of the other four segments (as shown in our interface diagrams)

NEON Inter-Segment Interfaces

NEON Inter-Element Interfaces
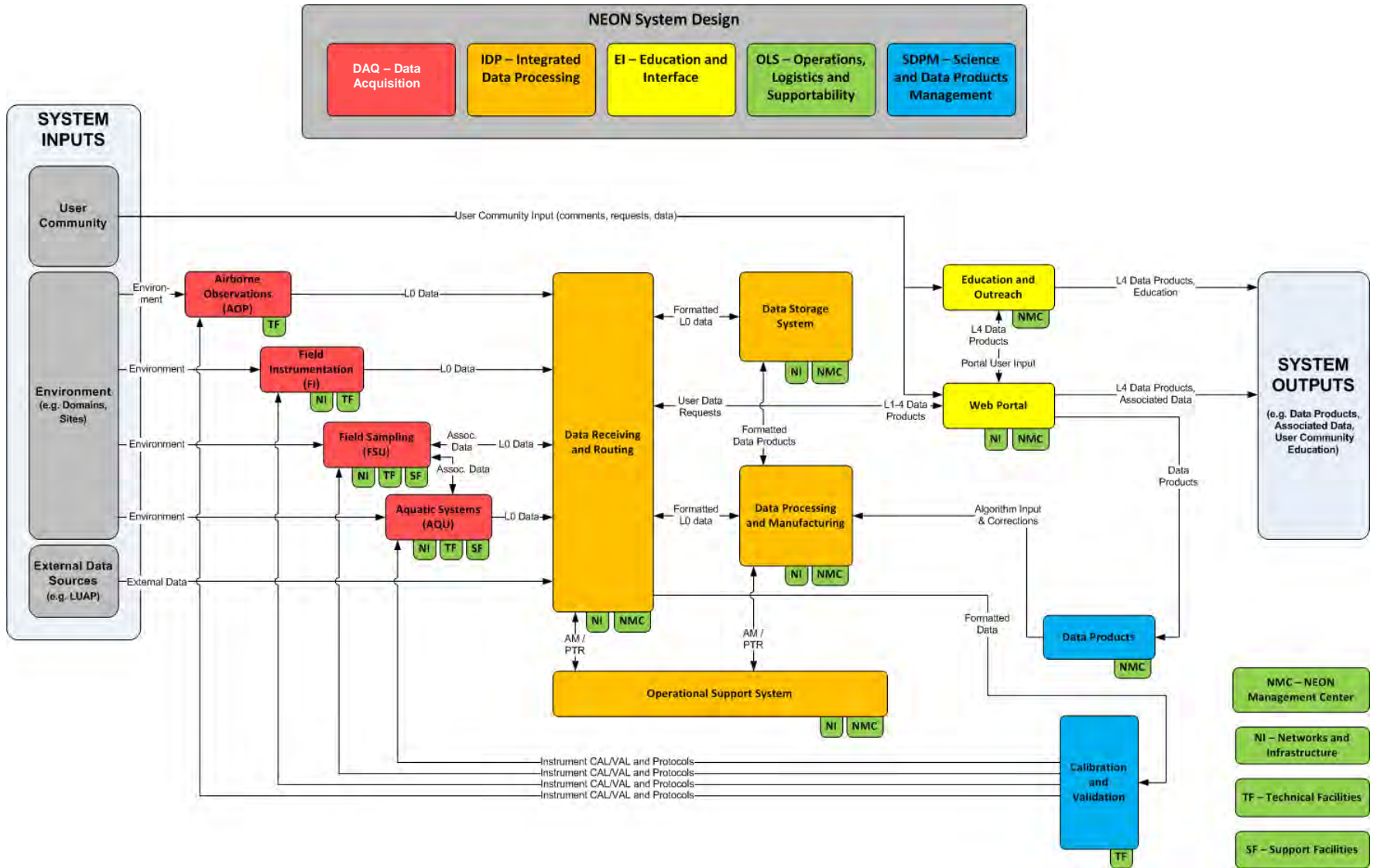
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System Requirements

Definition and Development Effort

- Since PDR, NEON System Engineering performed four primary activities/functions:

    1. **Development of both a high level System Design (functional decomposition) and Requirements Architecture**

        - As outlined

    2. **A Requirements Definition with respect to the overall System Engineering process**

        - Re-captured current requirements for derivation of system level requirements

        - Reviewed requirements for validity, traceability and verification

        - Performed Internal Requirements Reviews (IRRs) with all PTs

        - Integrated all project requirements into DOORS® with a structure and linkage based on the system functional design and architecture

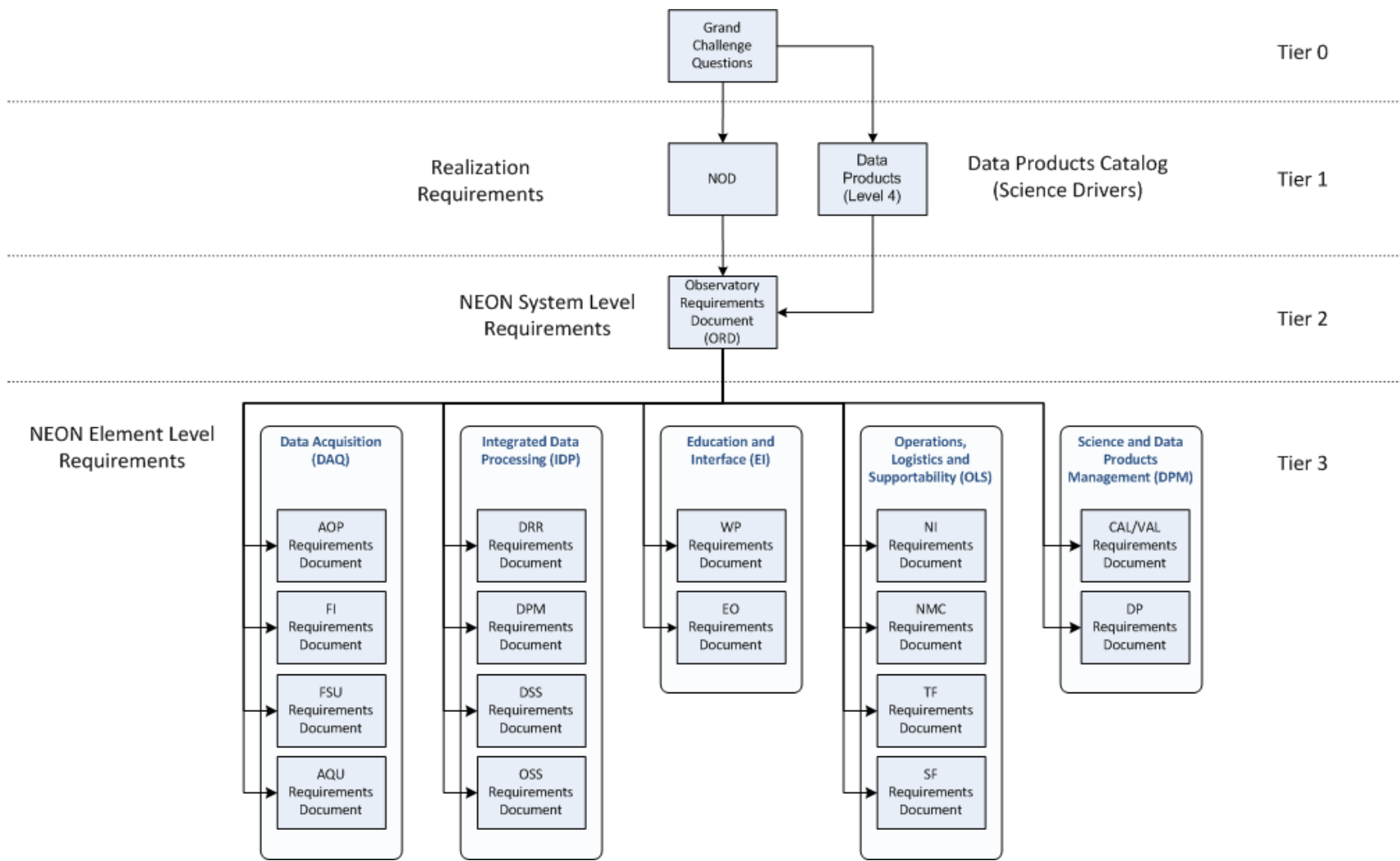# Definition and Development Effort

3. **Development of an overall NEON Observatory Requirements Document, or ORD (NEON.DSDV.SYS.004206.REQ)**

   - Captures all system level requirements (Tier 2) with respect to various areas (Performance, Segments, Operations, Data, EH&S, Security, Construction, Interfaces, etc.)

   - Provides general Product Assurance and Verification Provisions to include a system level verification matrix

   - Captures / Controls deliverable Data Products

4. **System Requirements Review (SRR)**

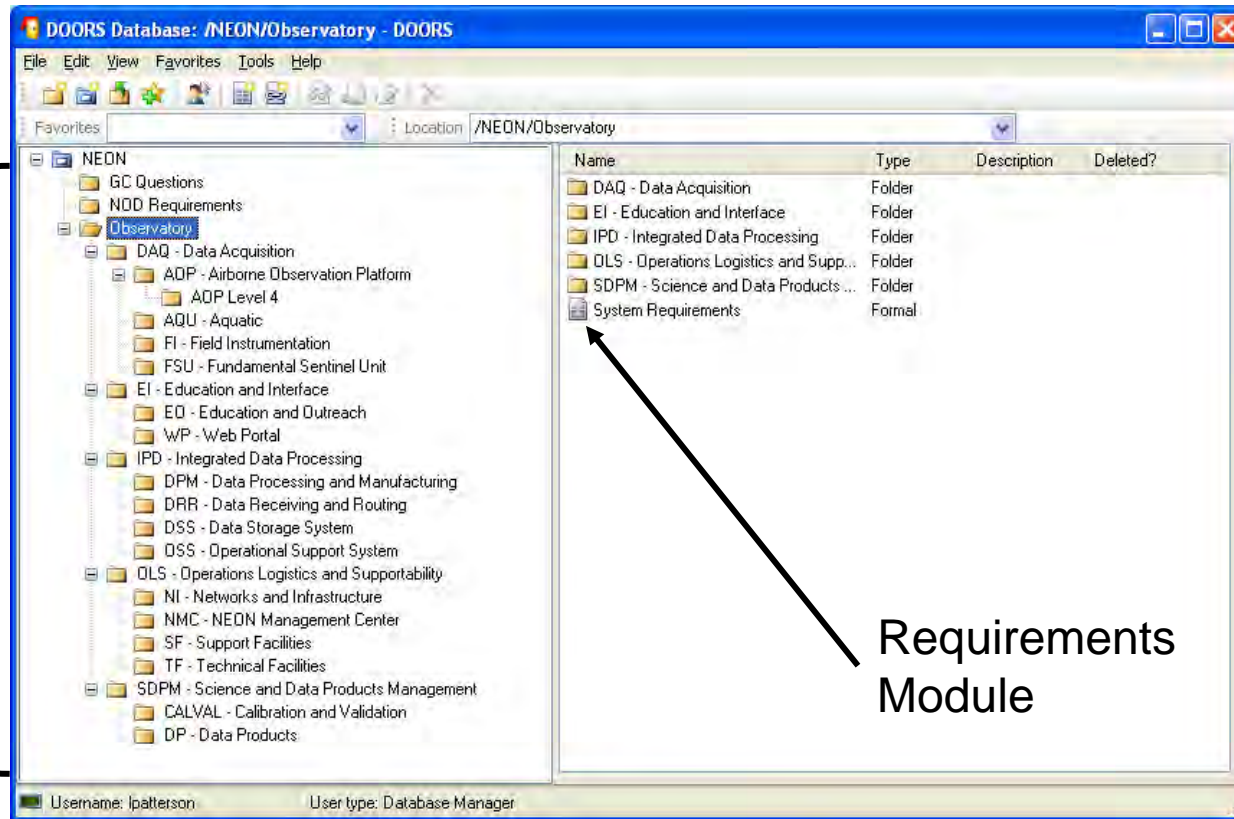   - September 24-25, 2009

NEON Requirements Architecture/Tree

NEON Requirements Schema

Grand Challenge Questions / Areas	No schema, these requirements will not be tracked as part of the baseline	Tier 0
Realization Requirements (NOD, Data Products Catalog)	NEON.001, NEON.002, …, NEON.xxx	Tier 1
NEON System Level Requirements	NEON.SYS.2.001, NEON.SYS.2.002, …, NEON.SYS.2.xxx	Tier 2
NEON Element Level Requirements	NEON.AOP.3.001, NEON.AOP.3.002, …, NEON.AOP.3.xxx NEON.FSU.3.001, NEON.FSU.3.002, …, NEON.FSU.3.xxx NEON.FI.3.001, NEON.FI.3.002, …, NEON.FI.3.xxx NEON.DPM.3.001, NEON.DPM.3.002, …, NEON.DPM.3.xxx . . . NEON.EEE.3.001, NEON.EEE.3.002, …, NEON.EEE.3.xxx	Tier 3
NEON Sub-System Level Requirements	NEON.AOP.4.001, NEON.AOP.4.002, …, NEON.AOP.4.xxx NEON.FSU.4.001, NEON.FSU.4.002, …, NEON.FSU.4.xxx NEON.FI.4.001, NEON.FI.4.002, …, NEON.FI.4.xxx NEON.DPM.4.001, NEON.DPM.4.002, …, NEON.DPM.4.xxx . . . NEON.EEE.4.001, NEON.EEE.4.002, …, NEON.EEE.4.xxx	Tier 4

DOORS® Requirements Database

Project-level view

Database Structure

Requirements Module

Note: Snapshot of Database provided for FDR ⇒ NEON Project Requirements Database DOORS® ID 36688 (NEON.DSDV.SYS.004221.REQ)

System Requirements Summary

- At the time of the SRR, NEON had a total of 1569 requirements

- Areas where requirements still need to be captured have been accounted for in the overall design and budget

NOD Requirements (Tier 1)	11
Total Tier 2 Requirements	120
Total Tier 3 Requirements	1438

System Element	Tier 3 Requirements
FSU (DAQ)	122
FI (DAQ)	527
AOP(DAQ)	26
AQU (DAQ)	171
OSS (IDP)	133
DPM (IDP)	53
DRR (IDP)	124
DSS (IDP)	26
WP (EI)	34
EO (EI)	12
NI (OLS)	9
NMC (OLS)	14
TF (OLS)	74
SF (OLS)	0
CAL/VAL (SDPM)	106
DP (SDPM)	7

SRR Out-brief

- NEON performed a System Requirements Review on the 24-25 September, 2009
  - Chaired by Richard Murowinski of ALMA
  - NEON SRR Plan available upon request (NEON.DSDV.SYS.004204.PLA)
    - Agenda, participating panel members, objectives, etc.
- SRR Panel Report provided to the NEON Project Manager on 16 October, 2009
  - With direct NSF participation, a separate SRR Panel Report was also provided to the NSF at the same time
- Actions/Recommendations have been captured via Review Item Discrepancies (RIDs)
  - 113 Total RIDs (103 Have been Closed)
  - 10, along with additional efforts formulated from the Panel's report, will be closed over the next 3-6 months

Summary

- **Observatory Design**
  - To address recommendations and actions from PDR, NEON has delivered a high-level system design and architecture
    - Addresses the *Physical Infrastructure* of the fundamental design aspects of the NEON mission strategy and goals
    - System engineering approach $\Rightarrow$ system functions and deliverables into dedicated elements/segments
    - Product Teams have responsibilities to execute and deliver designs in various areas $\Rightarrow$ not always one-to-one

- **Observatory Requirements**
  - Significant progress since PDR…
    - Performed an overall Requirements Definition effort…
      - Developed requirements schema and architecture
      - Captured requirements, determined verification and traceability
      - Baselined an Observatory Requirements Document (ORD) $\Rightarrow$ a solid foundation of what NEON, Inc. is required to deliver
    - Completed a NEON System Requirements Review (SRR)

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