Geophysical Monitoring System (GMS) for IDC Re-engineering

GMS
Geophysical
Monitoring
System
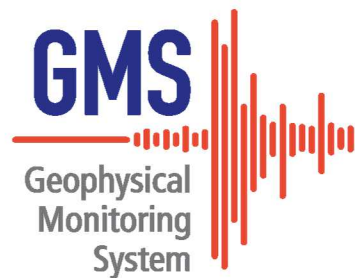
PRESENTED BY

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Topics

- The Sandia IDC Re-engineering Project

- Geophysical Monitoring System (GMS) Development

- Analyst Workspace Examples

- GMS 2019 Release

The Sandia IDC Re-engineering Project

Phases of IDC Re-engineering

- ## Re-engineering Phase 1 (RP1)
  - Enhance or replace major components of the system

- ## Re-engineering Phase 2 (RP2)
  - Design a unified architecture for all seismic, hydroacoustic, and infrasound (SHI) software
  - Included Sandia support to define IDC requirements, specifications, use cases, and storyboards

- ## Re-engineering Phase 3 (RP3)
  - Development and deployment of components based on the architecture designed in RP2
  - IDC Defined Two Options for RP3
    - Option A: if US NDC Modernization contribution – work with new architecture
    - Option B: if no US contribution – evolve the current system

IDC Re-engineering Timeline
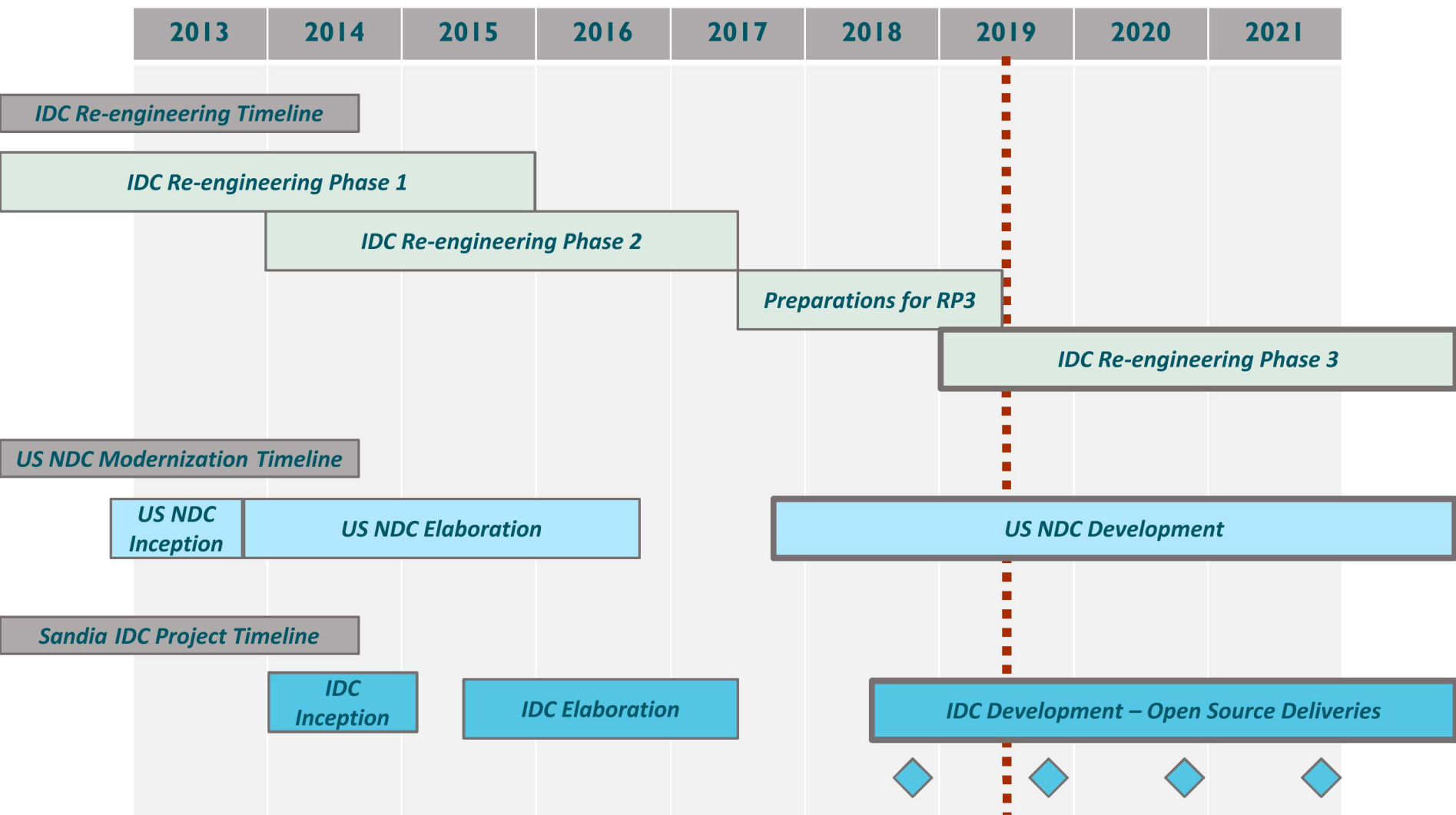
United States Support for IDC Re-engineering Development

- US stakeholders desire to support IDC RP3 Development in an effective and affordable manner, leveraging the US NDC Modernization System Development

- US has funded software delivery as a "Managed Open Source Project"
  ◦ Includes common components from USNDC Modernization
  ◦ Generic runnable system (not configured specifically for IDC)
  ◦ Limited SNL support for IDC testing and evaluation

- Dec 2018 – First GMS Open Source Release
  ◦ PI 3 software release – very limited functionality, not buildable externally

- 2019 – Working toward Next Release
  ◦ Generic buildable, runnable system

The Geophysical Monitoring System (GMS)

- The US National Data Center (US NDC) has funded Sandia National Laboratories to develop a new system for US NDC Modernization

- This is the Geophysical Monitoring System (GMS)

- GMS Vision – build a new system to meet US NDC mission requirements that improves maintainability, extensibility, testability, etc.

- The IDC and US NDC have substantial overlap in processing system requirements and needs

- To support IDC Re-engineering development, applicable GMS components will be released as open source
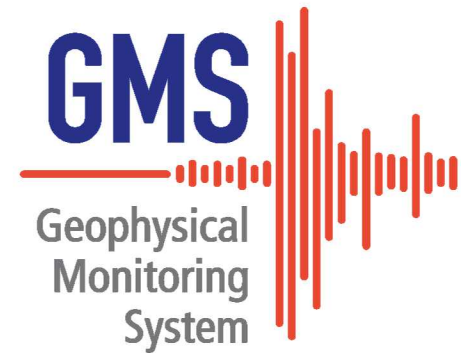
Using Agile Software Development Techniques

Scaled Agile Framework - SAFe
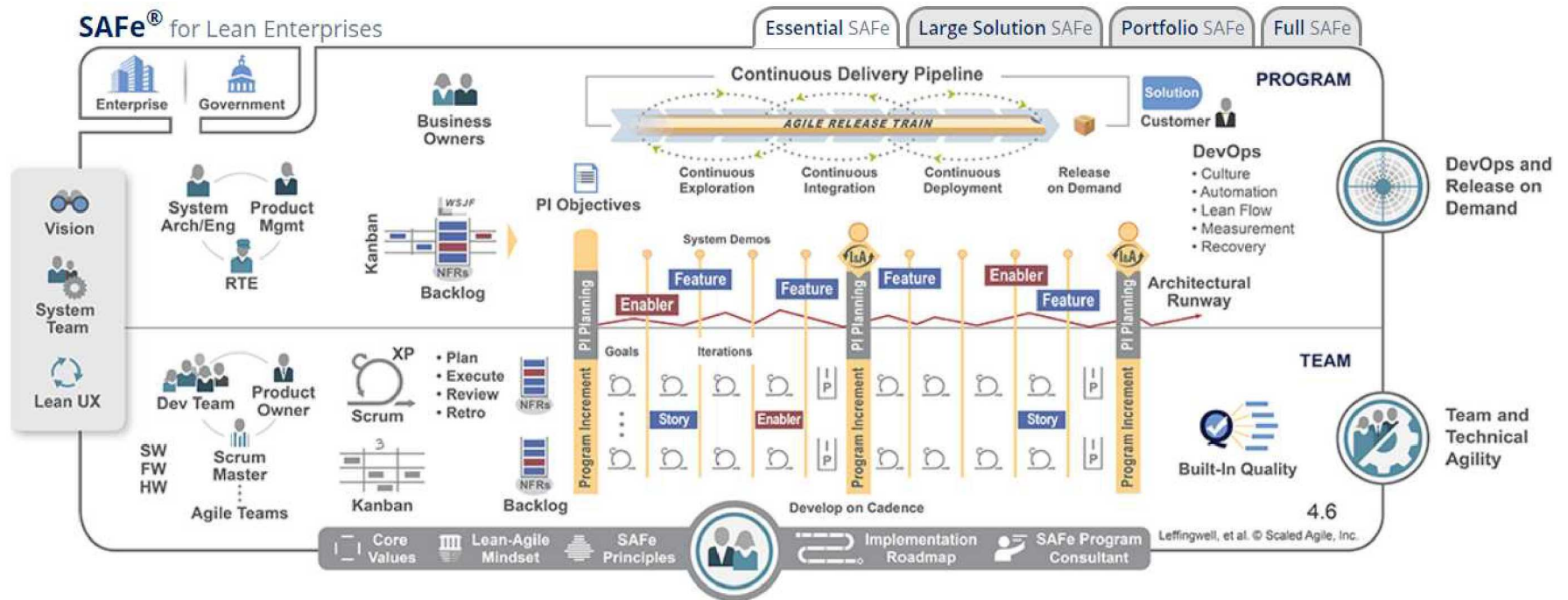
- Iterative Development – 12 week Program Increments, 2 week Sprints
- Program Increments planned together by Sandia and US NDC
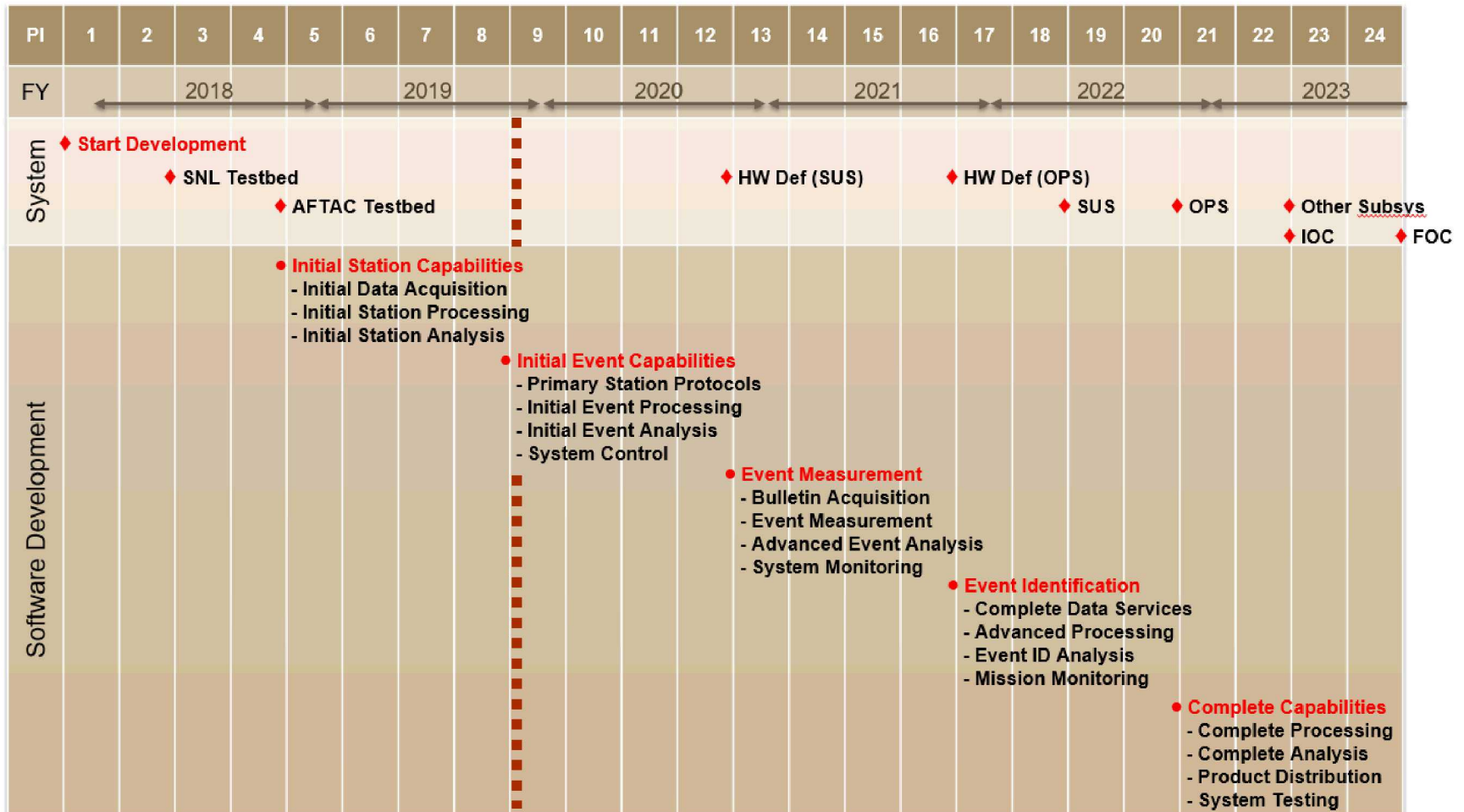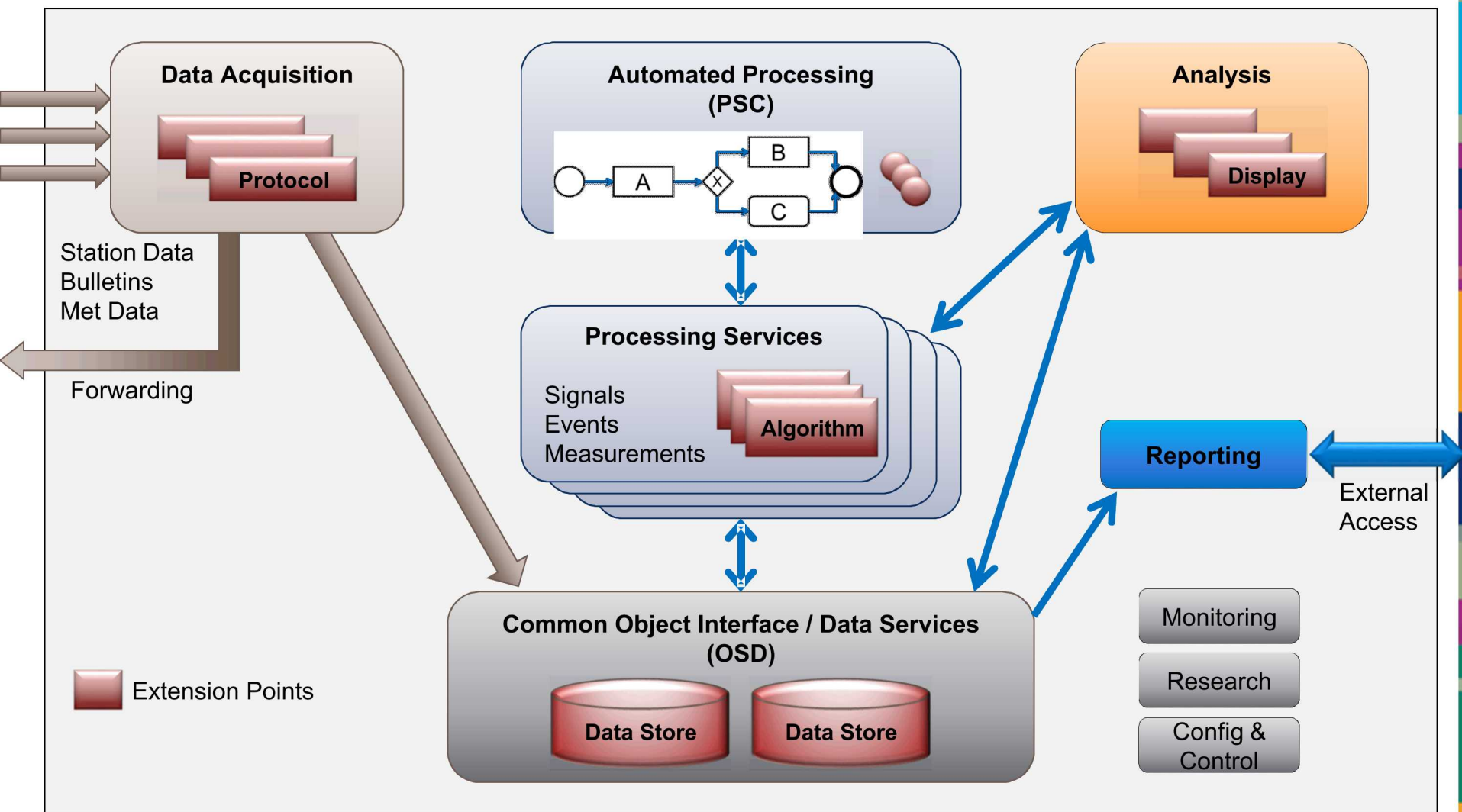- Sandia and US NDC collaboration on engineering, development, and testing
- Continuous Integration / Continuous Delivery
  - Testbeds at Sandia and US NDC – updated each Program Increment

Working toward Annual Milestones

PI	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
FY		2018				2019				2020				2021				2022				2023		

System

♦ Start Development

♦ SNL Testbed

♦ AFTAC Testbed

♦ HW Def (SUS)

♦ HW Def (OPS)

♦ SUS

♦ OPS

♦ Other Subsys

♦ IOC   ♦ FOC

Software Development

● Initial Station Capabilities
- Initial Data Acquisition
- Initial Station Processing
- Initial Station Analysis

● Initial Event Capabilities
- Primary Station Protocols
- Initial Event Processing
- Initial Event Analysis
- System Control

● Event Measurement
- Bulletin Acquisition
- Event Measurement
- Advanced Event Analysis
- System Monitoring

● Event Identification
- Complete Data Services
- Advanced Processing
- Event ID Analysis
- Mission Monitoring

● Complete Capabilities
- Complete Processing
- Complete Analysis
- Product Distribution
- System Testing

Architecting for System Qualities

- **Extensibility** (add/replace processing components, displays, data storage, other mechanisms)

- **Maintainability** (SE, models, standards, collaboration with maintainers)

- **Scalability** (redundant 24/7 data centers → down to laptop)

- **Usability** (consistent, modern UI)

- **History** (capture and use provenance of results)

- **Configurability** (all parameters accessible for tuning)

- **Flexibility** (easily change data processing and analyst workflow)

- **Platform Independence** (use open, extensible technologies)

- **Longevity** (plan for 20-year life)

- **Growth** (expecting exponential growth of data, new processing techniques)

- **Testability** (data replay and analyst action replay at system level)

- **Security** (must meet standards)

GMS High Level Architecture

Data Acquisition

Protocol

Station Data
Bulletins
Met Data

Forwarding

Automated Processing
(PSC)

A
B
C
x

Processing Services

Signals
Events
Measurements

Algorithm

Analysis

Display

Reporting

External
Access

Common Object Interface / Data Services
(OSD)

Data Store

Data Store

Extension Points

Monitoring

Research

Config &
Control

Software Architecture Layers

- The GMS software architecture can be viewed as a set of layers
  - **User Interface** – The User Displays, organized into User Interfaces, together with supporting components
  - **Application** - The orchestration of services into processing workflows that implement the core mission logic
  - **Service** – Software functions supporting automatic processing workflows and User Interface interactions
  - **Data Access** – Interface software providing access to persistent data while encapsulating the underlying storage implementation
  - **Framework** - Shared project software providing common support functions and implementing standard patterns

- Higher layers depend on lower layers

Software Development Infrastructure

Analyst Workspace Examples
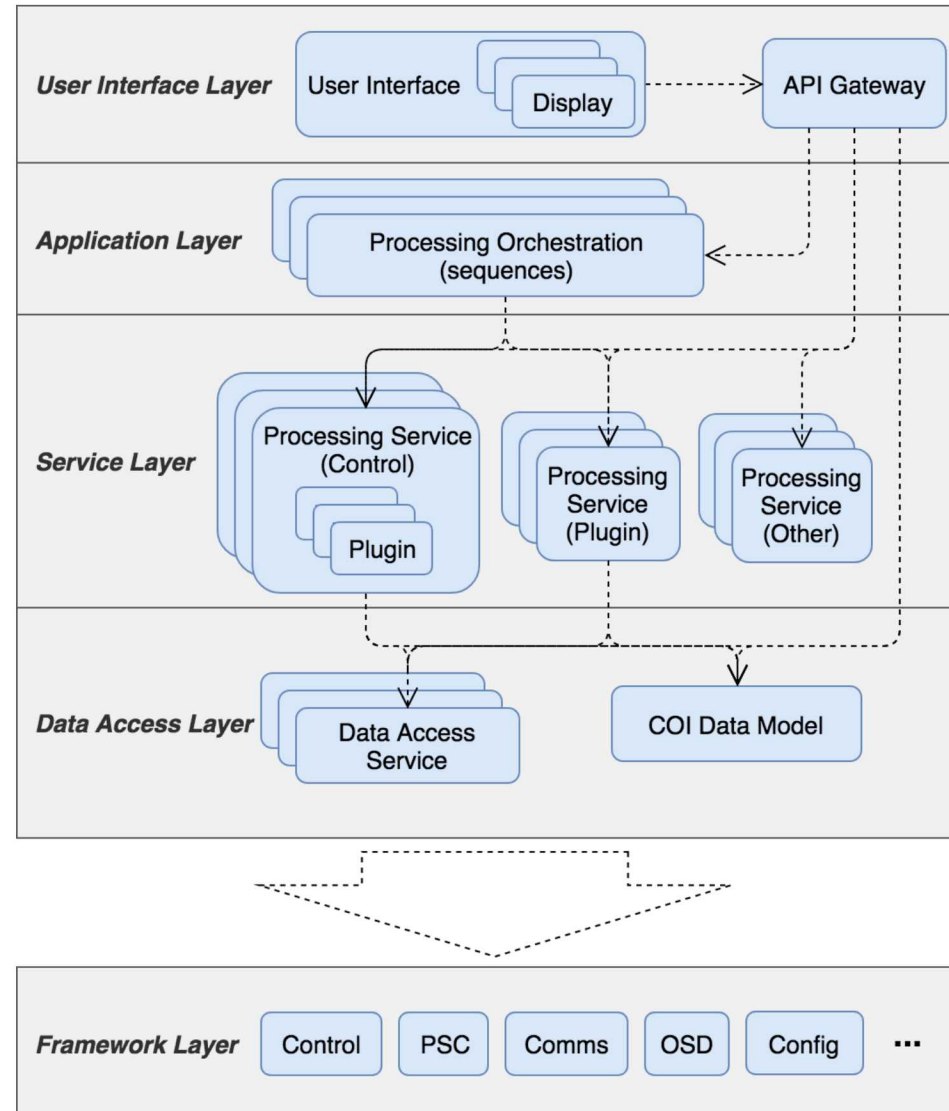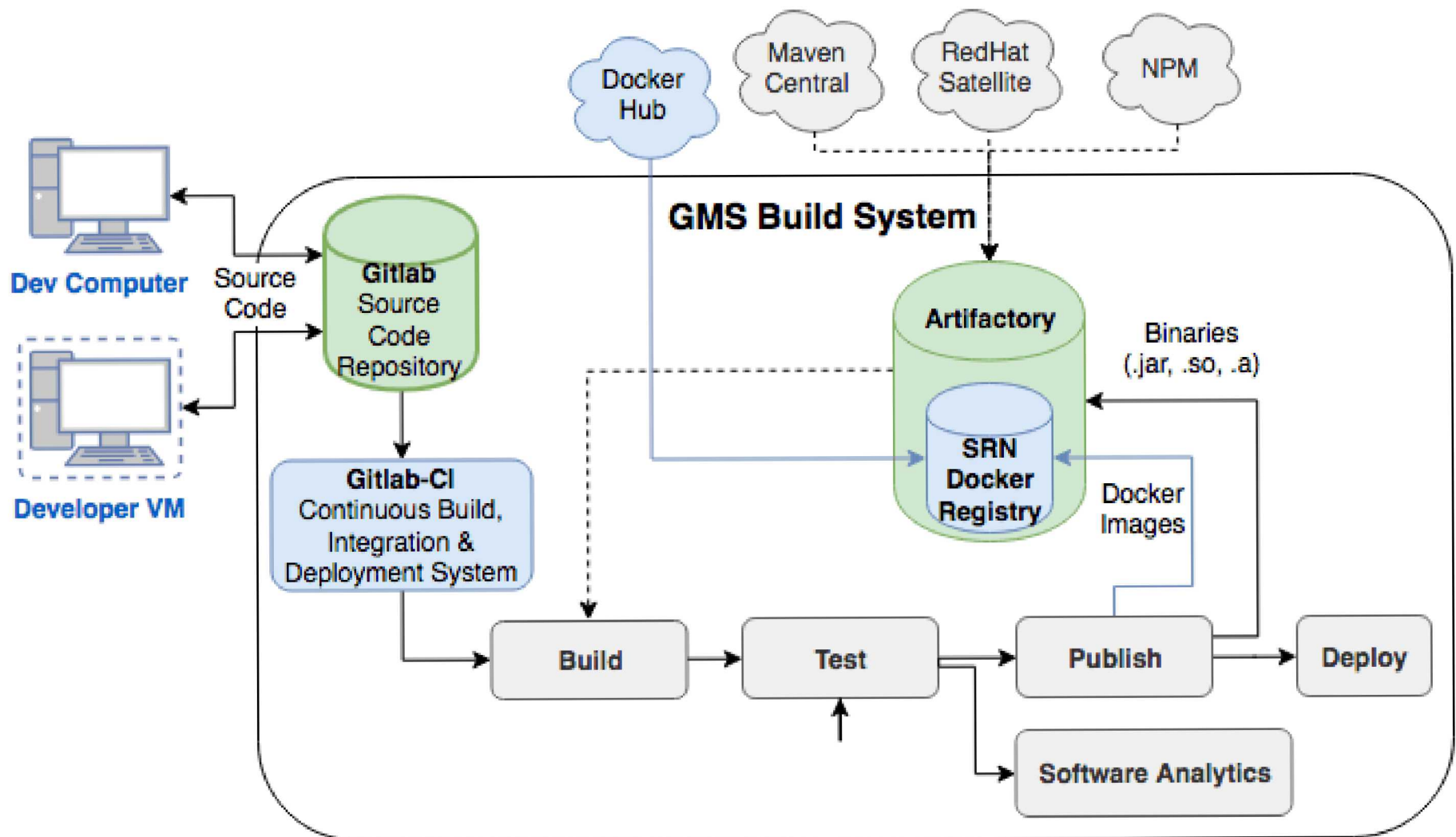
The Analyst Workspace

- Manages the displays used for Analysis as a system
  - Workflow
  - Waveforms Display
  - Event List
  - Signal Detection List
  - Map
  - Azimuth/Slowness (FK)
  - Amplitude Measurement
  - Location
  - Magnitude

- Developed using web technologies
  - Common UI features – multi-paned, tabbed panels
  - Supports both browser and desktop app deployments

- Workspace layout is user-customizable

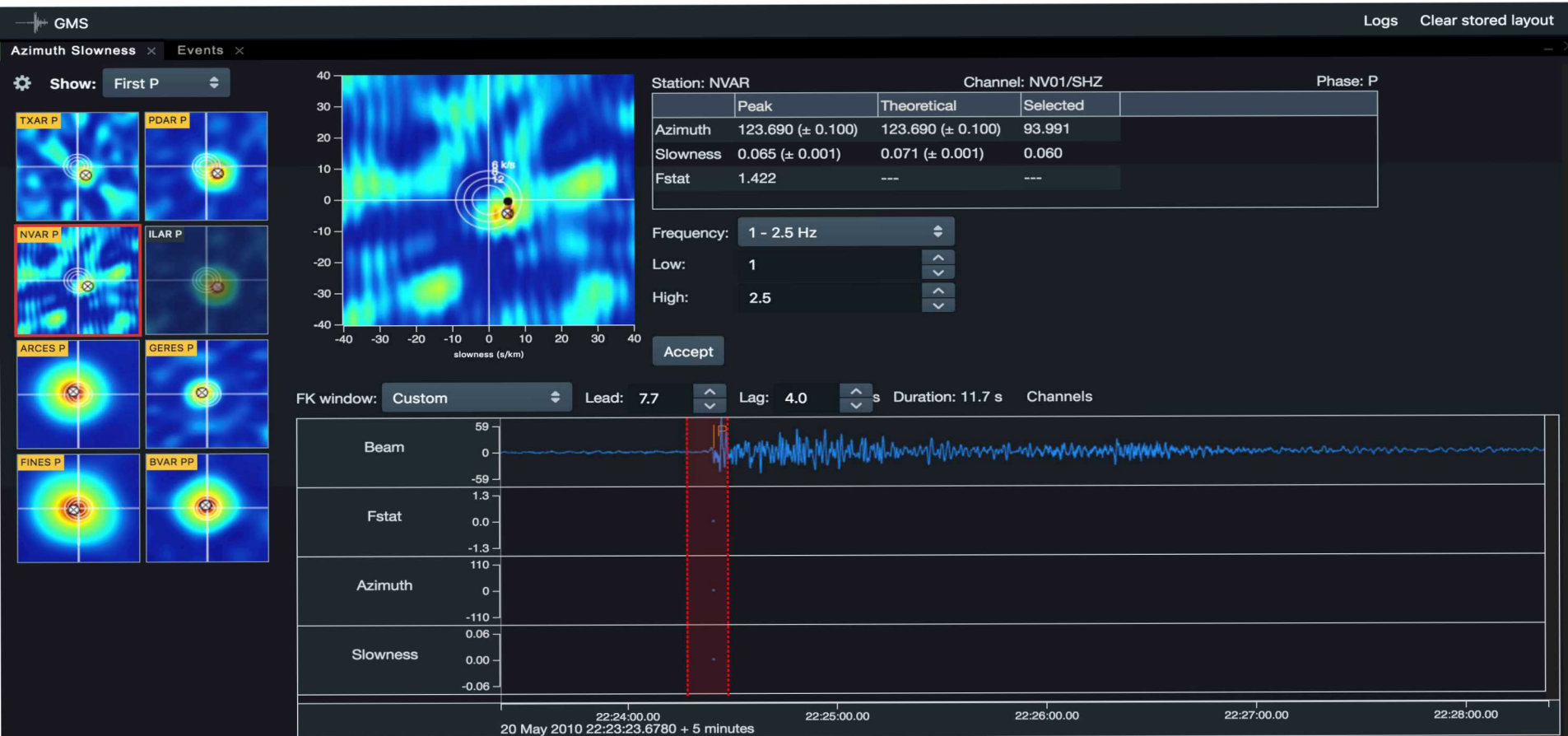- Data is synchronized across all workspace displays
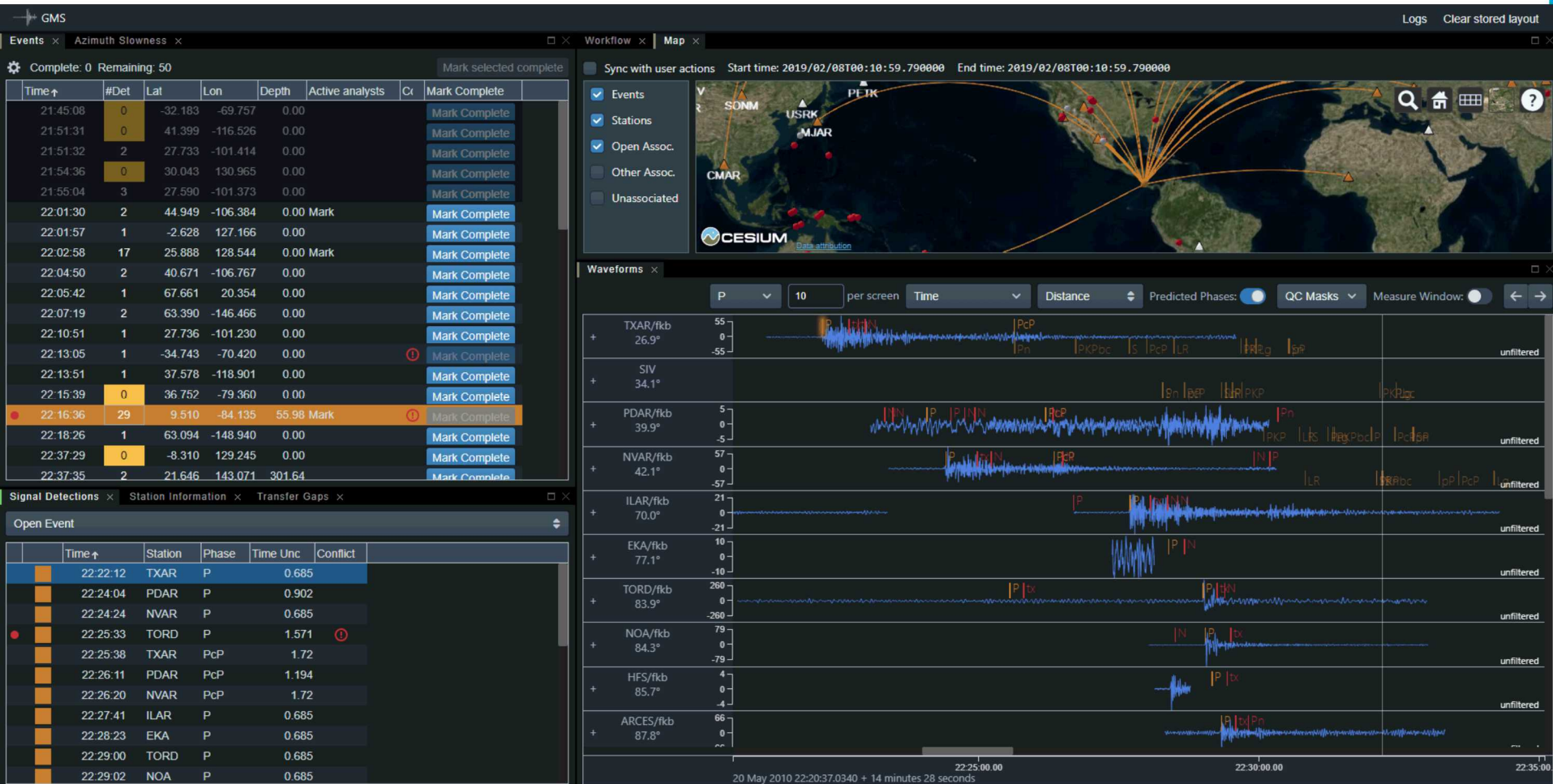
Analyst Workspace

Analyst workspace - different layout
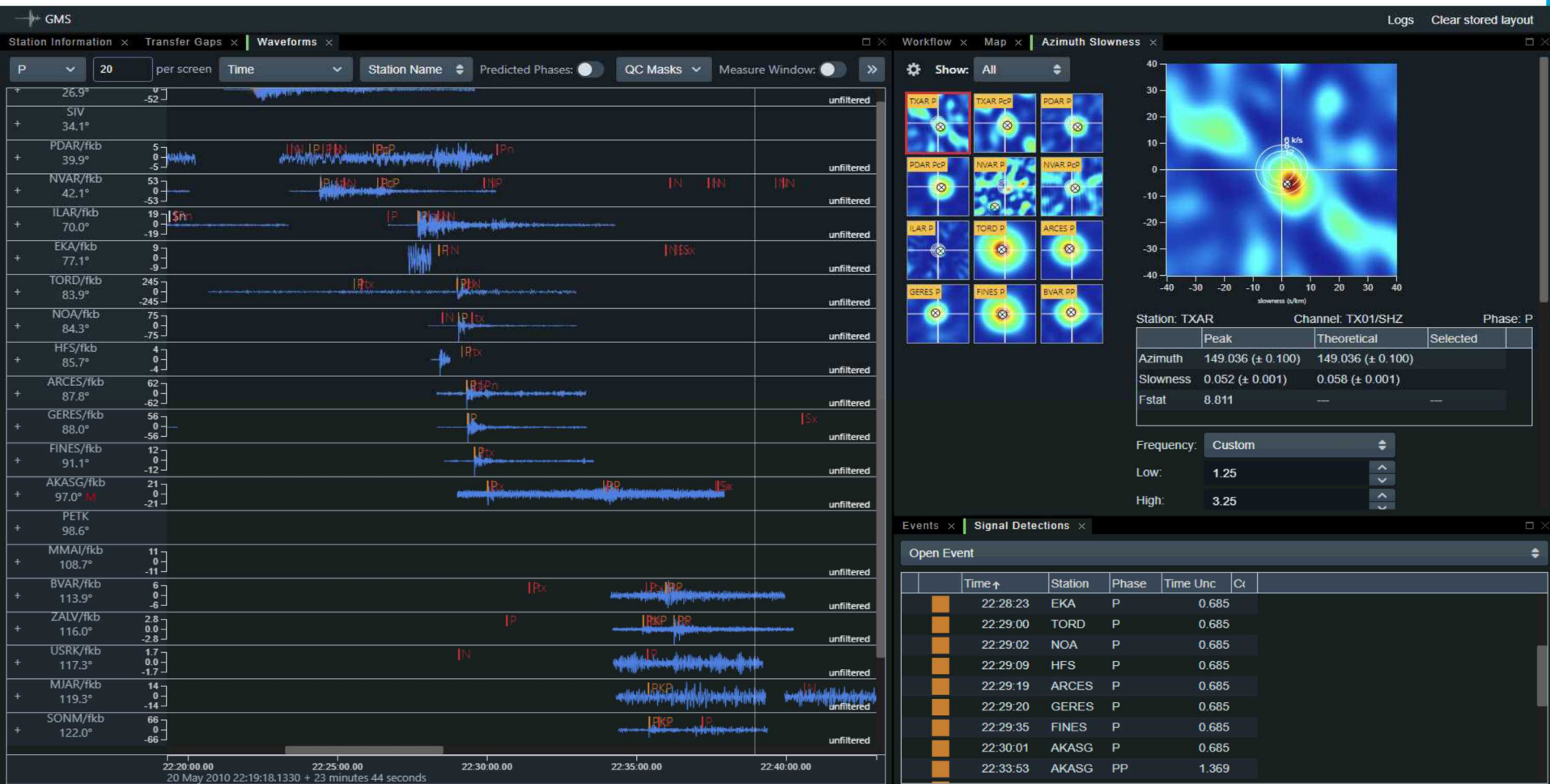
Beginning Map functionality
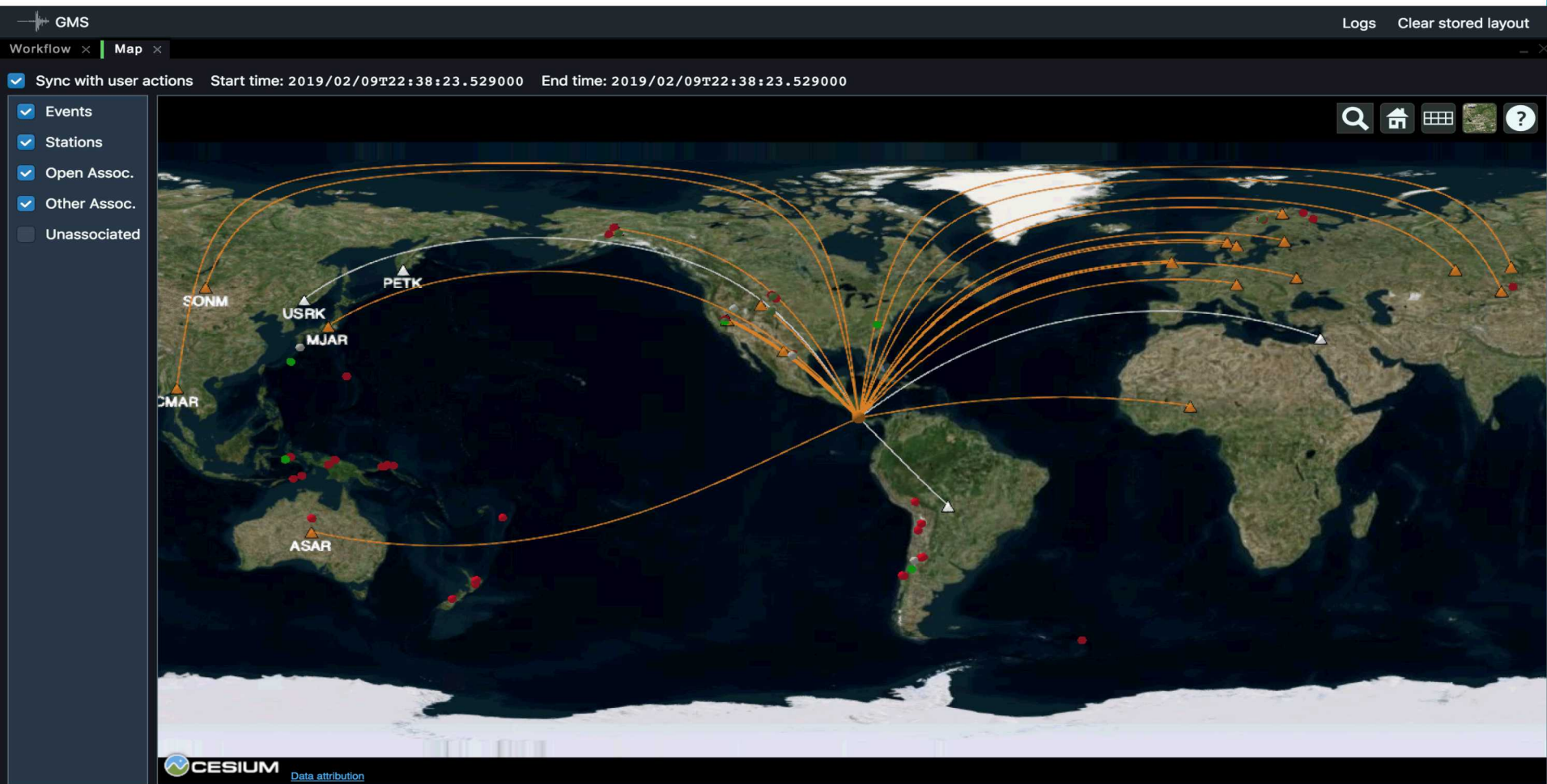
Azimuth/Slowness (FK) Display

Waveform Display incudes a new Measurement Window
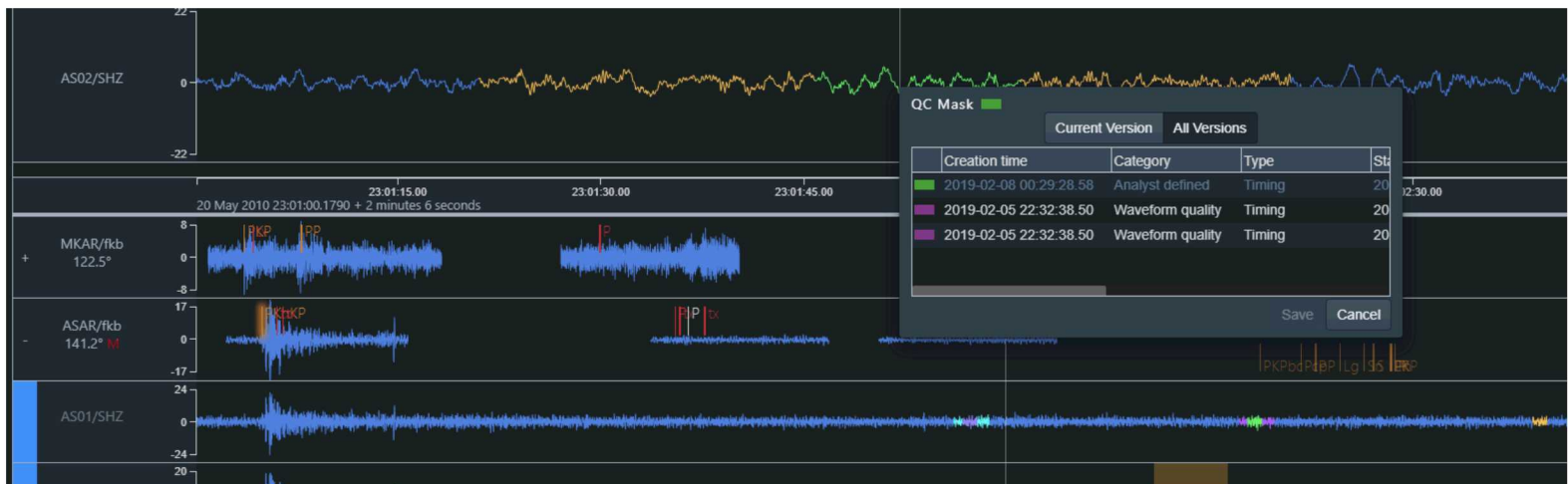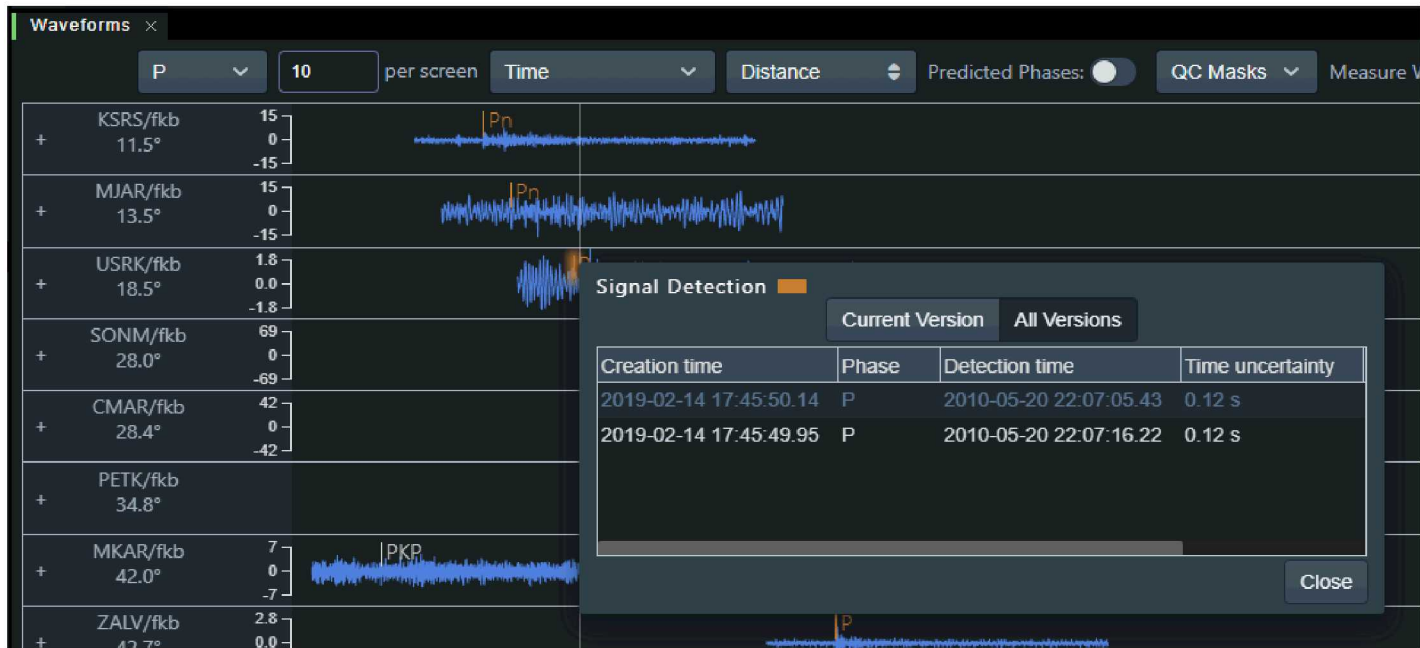
Signal Detection and QC Mask version history is available

GMS 2019 Release

Capabilities Expected in PI 7 Release

- **Acquisition**
  - Station Data Acquisition (CD-1.1)
  - Station Data Acquisition (CSS 3.0)
  - Station Data Acquisition (MiniSEED)
  - Station Data Acquisition (IMS 2.0)
  - Cross Partition Data Transfer
  - Data Acquisition Status Display (Gaps in Transfer)
  - Data Acquisition Configuration Display
 - Station SOH Display

- **Processing**
  - Processing Sequence Execution - initial station and network processing
  - Processing Sequence Configuration Display
  - Waveform QC - SOH and simple data quality problems
  - Linear Filtering - FIR filters
  - Beamforming
  - Power Detector (STA/LTA) - standard algorithm
  - Onset Time Refinement (AIC)
  - FK Spectra
  - FK Measurements – azimuth, slowness, fstat
  - Feature Prediction – 1D time, azimuth, slowness, magnitude correction
  - Event Building – preliminary events
  - Event Location

- **Analysis**
  - Data Selection Display
  - Waveform Display
  - Event List Display
  - Signal Detection List Display
  - Map Display
  - Waveform Data Quality Analysis
  - Waveform Filtering
  - Signal Detection Analysis
  - FK Analysis
  - Event Building – manual association
  - Event Location
  - Event Magnitude

- **Operations**
  - COI Data Service

PI 7 System

2019 Release Plans
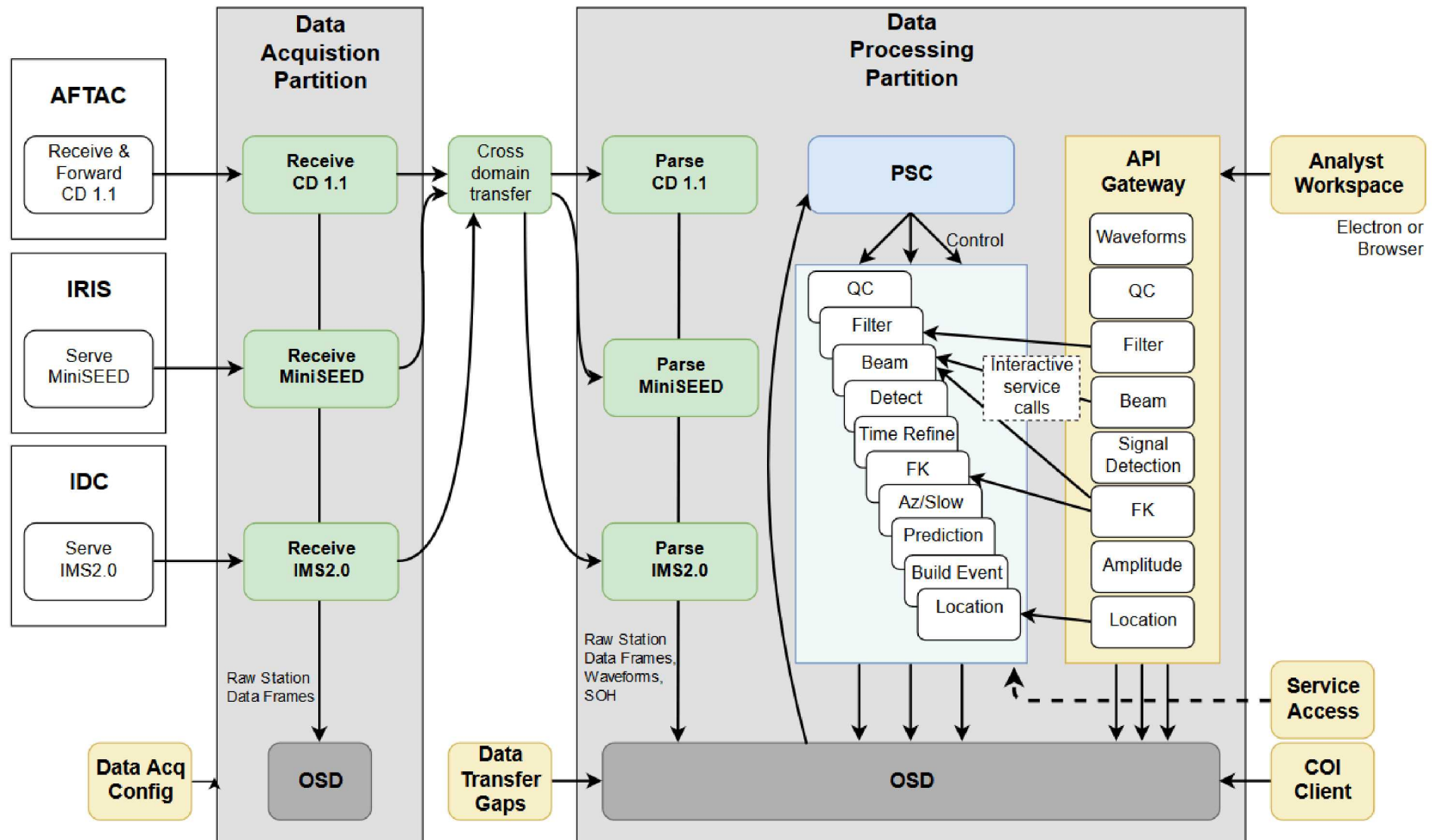
- GMS PI 7 Release (code complete in May 2019)
  - Posted as soon as review and approval complete – at least by end of year
  - Common Components Configured as a "Generic Runnable System"
  - Buildable from released source code
  - Runnable in a virtual testbed environment
  - Using Docker compose or Docker Swarm

- Release Content
  - Software, Build files, Instructions, Design Documentation

- Many operational aspects of the system will still be immature
  - Configuration
  - Control
  - Monitoring
  - Performance
  - Only simple versions of algorithms
  - No multi-analyst support