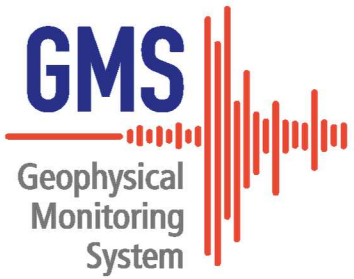
SAND2019-7106PE

IDC Re-engineering - Geophysical Monitoring System (GMS) Overview



PRESENTED BY

J. Mark Harris

Technical Meeting on SHI Software Engineering at the IDC
1-2 July 2019

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND2019-XXXX C

Topics

US NDC Modernization Status

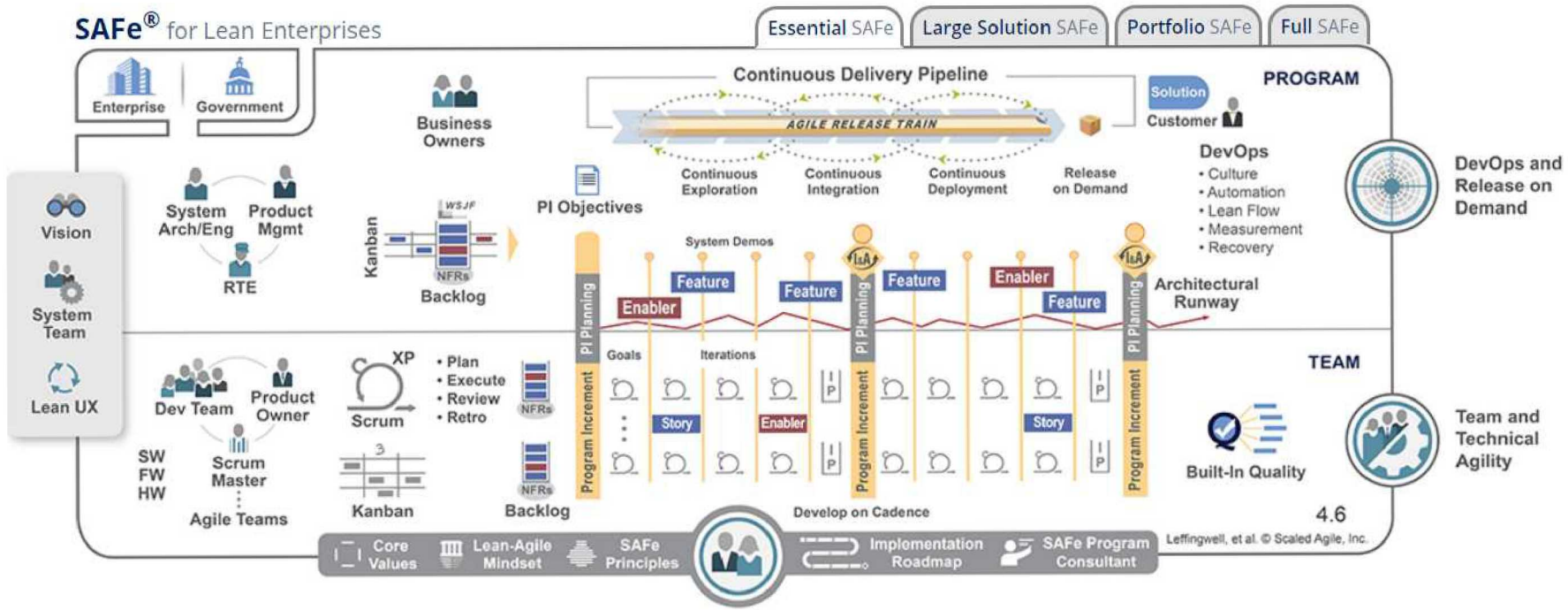
Sandia IDC Re-engineering Project

GMS 2018 Release

GMS 2019 Release

US NDC Modernization Status

Using the Scaled Agile Framework



SAFe

Program Increments (12 weeks)

Guided by Solution Intent

- Requirements, Use Cases, Storyboards, Qualities, Architecture

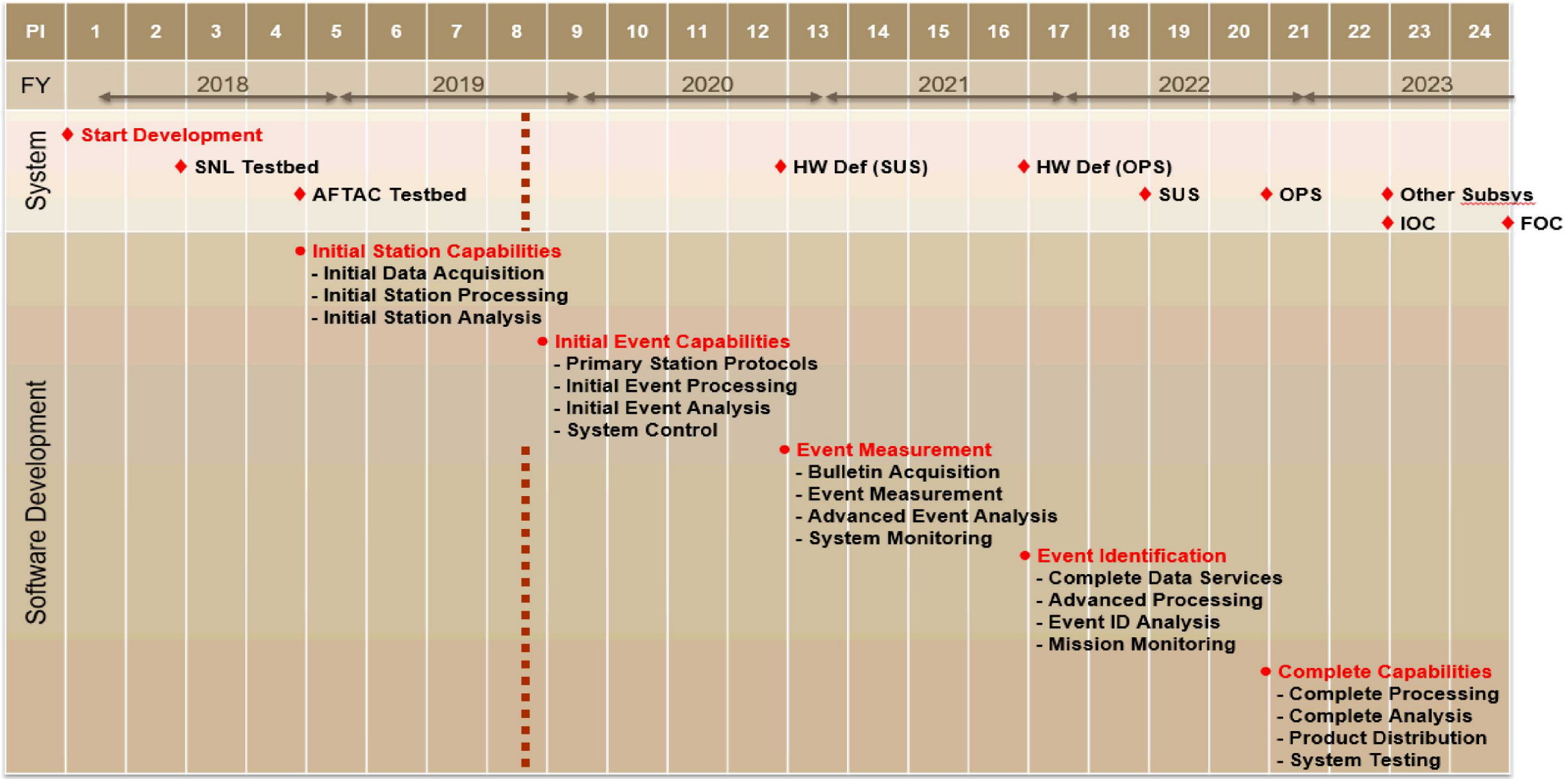
SNL and AFTAC collaboration on engineering and development

Testbeds at SNL and AFTAC – updated each PI

Teams

- Four Development Teams
  - Data Acquisition
  - Station Processing
  - Network Processing
  - Analysis
- System Team
- System Engineering Team
- Architecture Team
- Subject Matter Experts (SME) Team

Annual Milestones for GMS Development



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)

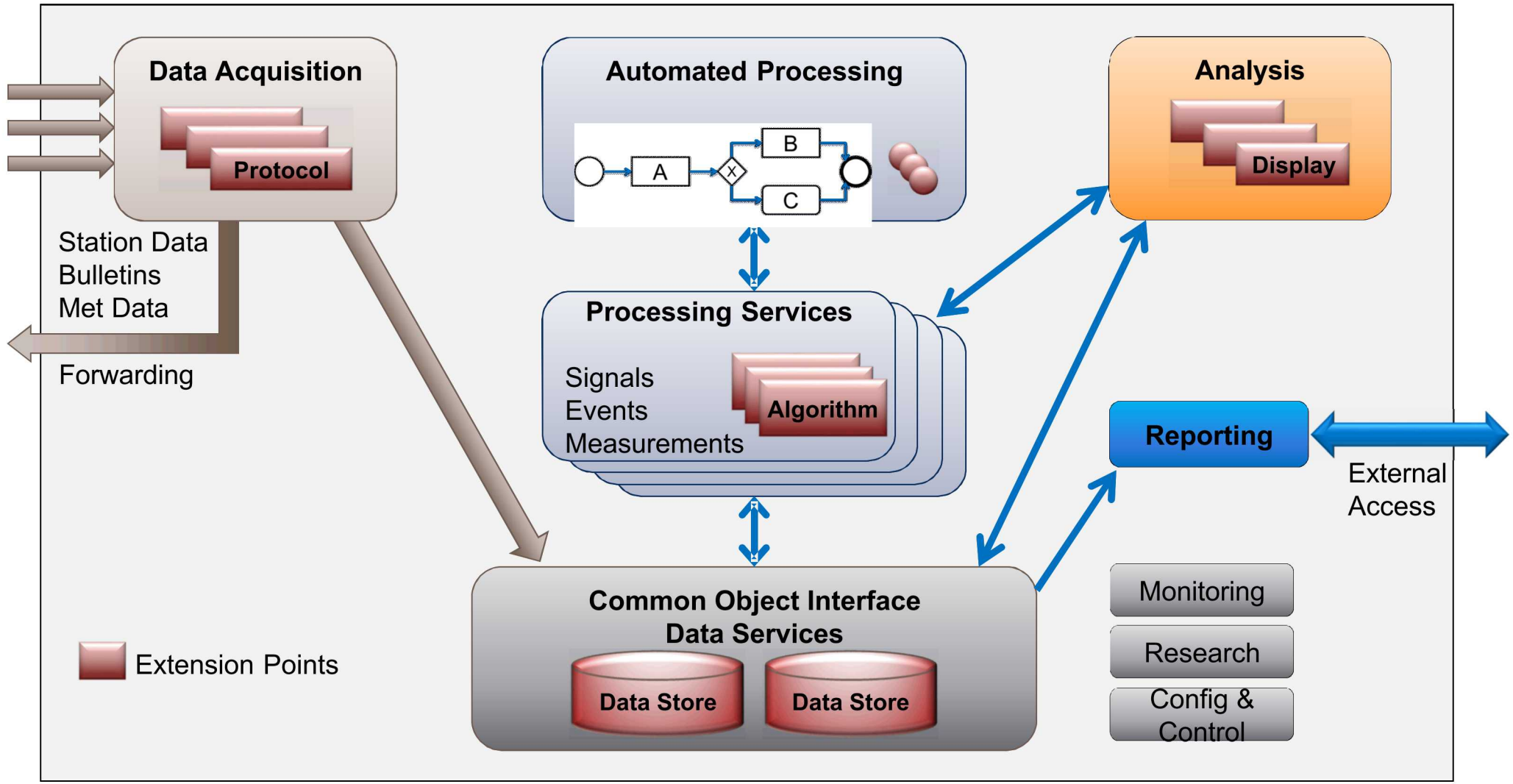
Longevity (plan for 20-year life)

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

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

Security (must meet applicable standards)

GMS High Level Architecture



Sandia IDC Re-engineering Project

Phases of IDC Re-engineering

Re-engineering Phase 1 (RP1)

- Enhance or replace major components of the system

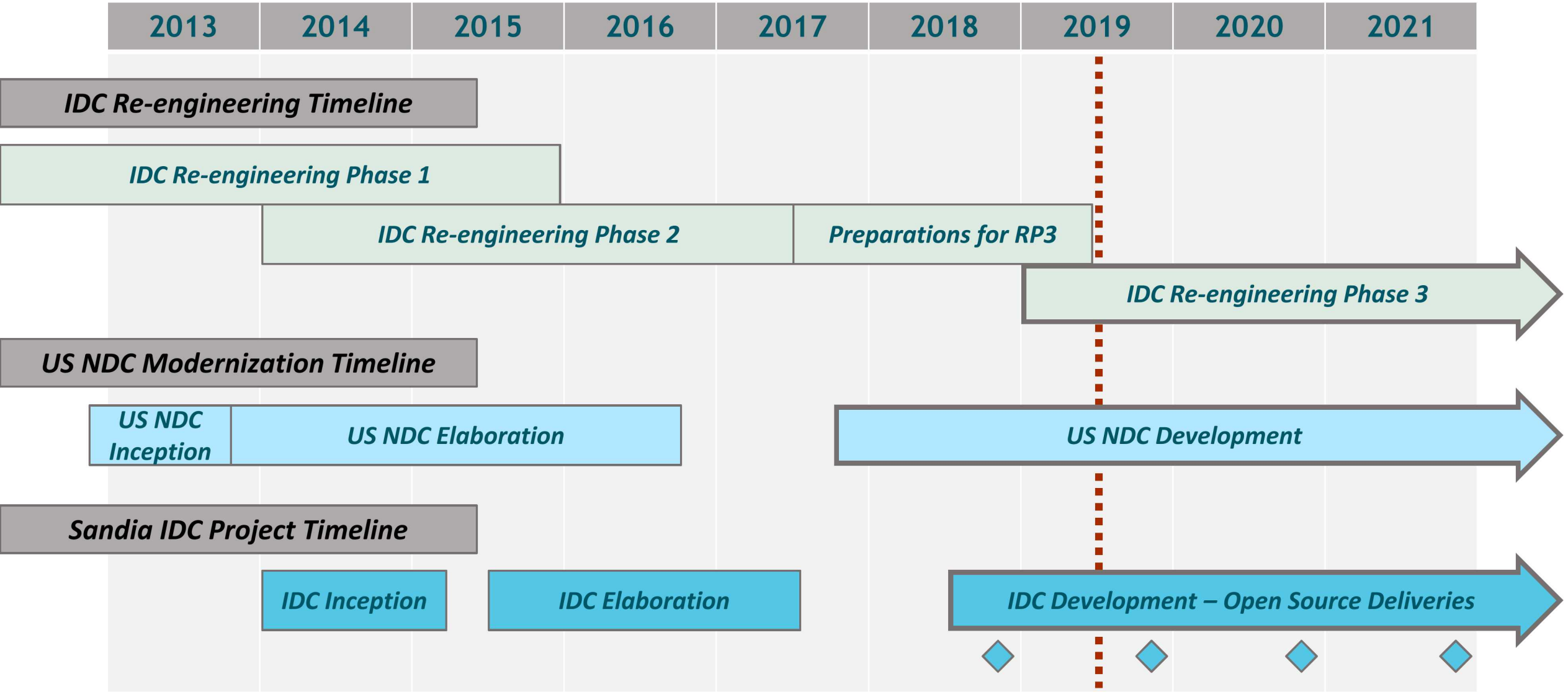
Re-engineering Phase 2 (RP2)

- Design a unified architecture for all seismic, hydroacoustic, and infrasound (SHI) software
- Included Sandia support to help document IDC requirements, specifications, use cases, and storyboards

Re-engineering Phase 3 (RP3)

- Development and deployment of components based on the architecture designed in RP2
- Leveraging US Contribution-in-Kind of common components from system development for US NDC Modernization
- Substantial effort at IDC to integrate, test, and develop IDC-unique components
  – much opportunity for contributions by the community

IDC Re-engineering Timeline



United States Support for IDC Re-engineering Development

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

To help meet the needs of the IDC, the US is contributing the Geophysical Monitoring Software (GMS) developed for US NDC Modernization

Software delivery is an 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

- Program Increment 3 software release – very limited functionality, not buildable externally

2019 – Working toward Next Release

- Generic buildable, runnable system

GMS 2018 Release

2018 Release (PI 3) Capabilities

Most features are an initial minimal implementation

Acquisition
- Station Data Acquisition (CD-1.1)
- Station Data Acquisition (CSS3.0)
- Cross Partition Data Transfer

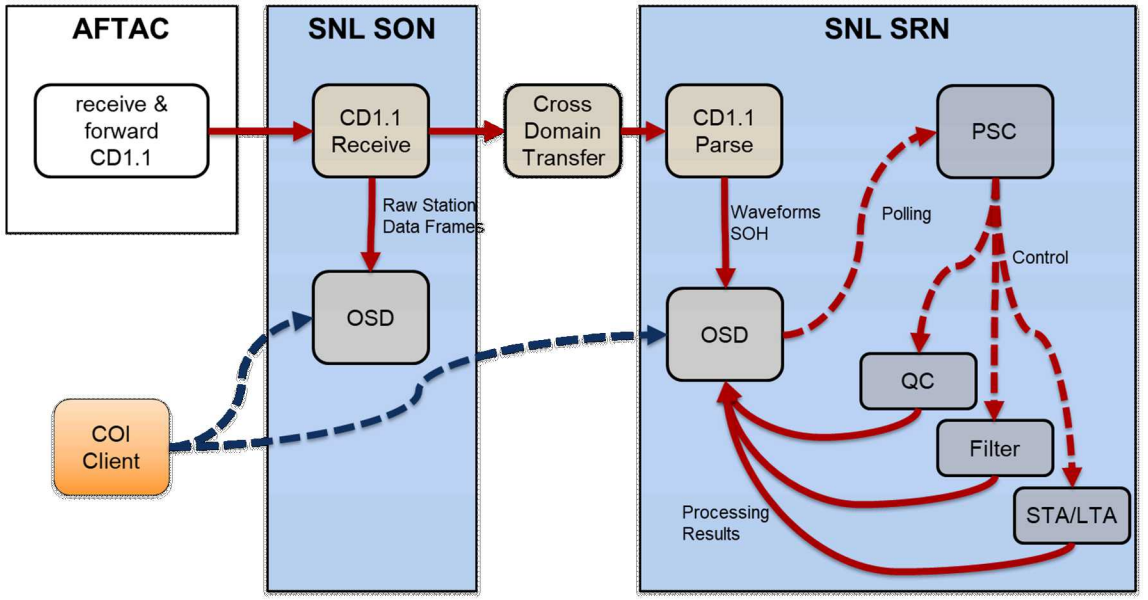
Processing
- Processing Sequence Execution - initial station and network processing
- Waveform QC - SOH and simple data quality problems
- Linear Filtering - FIR filters
- Power Detector (STA/LTA) - standard algorithm

Analysis
- Data Selection Display
- Waveform Display
- Event List Display
- Signal Detection List Display
- Map Display
- Waveform Data Quality Analysis
- Signal Detection Analysis
- FK Analysis

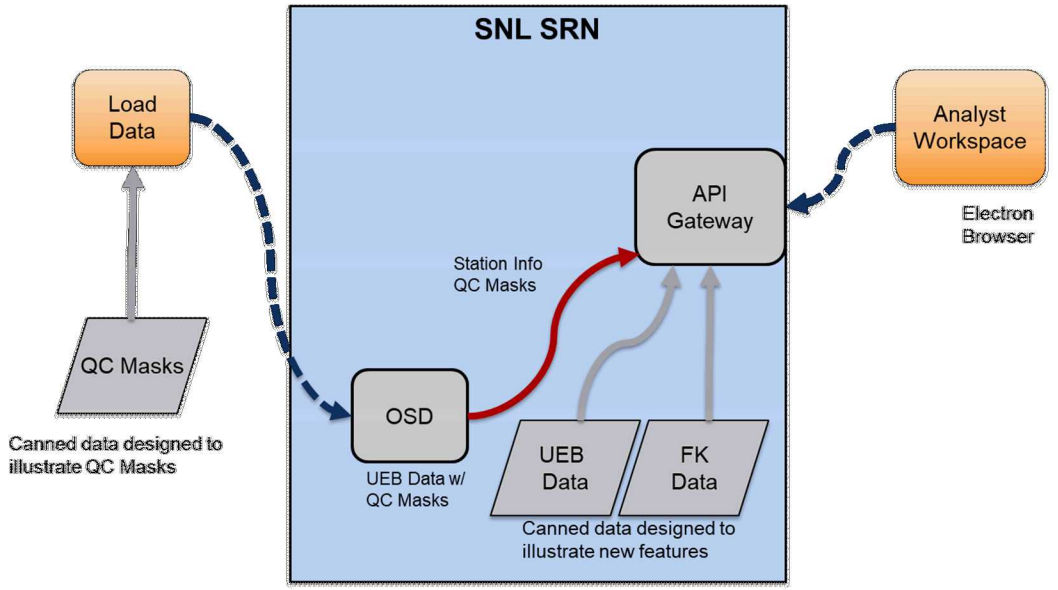
Operations
- COI Data Service – station info, waveforms, processing results

PI 3 Demonstration System (SNL Testbed)

Data Acquisition and Processing



Analysis



PI 3 Release Limitations

This initial release of the GMS common source code is provided for evaluation of design and is not for operational use

- Receiving data from a small number of stations (<10)
- Only processing one station
- Analysis tools are limited to one user

The PI 3 release is not buildable or runnable

- PI 3 code repository structure was causing significant build issues
  - GMS transitioned to mono-repo in PI 4
- Substantial information security issues were found in the PI 3 release that had to be removed
  - Build tool configuration, deployment files, test data
  - GMS is refactoring to separate code and configuration
- PI 3 required OpenShift platform for deployment and test
  - Complex and expensive
  - GMS is moving to simpler Docker deployment environment

Future versions will support testing in an operational environment

GMS 2019 Release

2019 Release Plans

GMS Development is planned through 2023
- US plans an Open Source release each year

GMS 2019 Release (PI 7 code completed in May)
- 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

GMS development is less than 1/3 complete
– most operational aspects of the system are still immature
- Configuration
- Control
- Monitoring
- Performance
- Only simple versions of algorithms
- No multi-analyst support

Capabilities 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 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

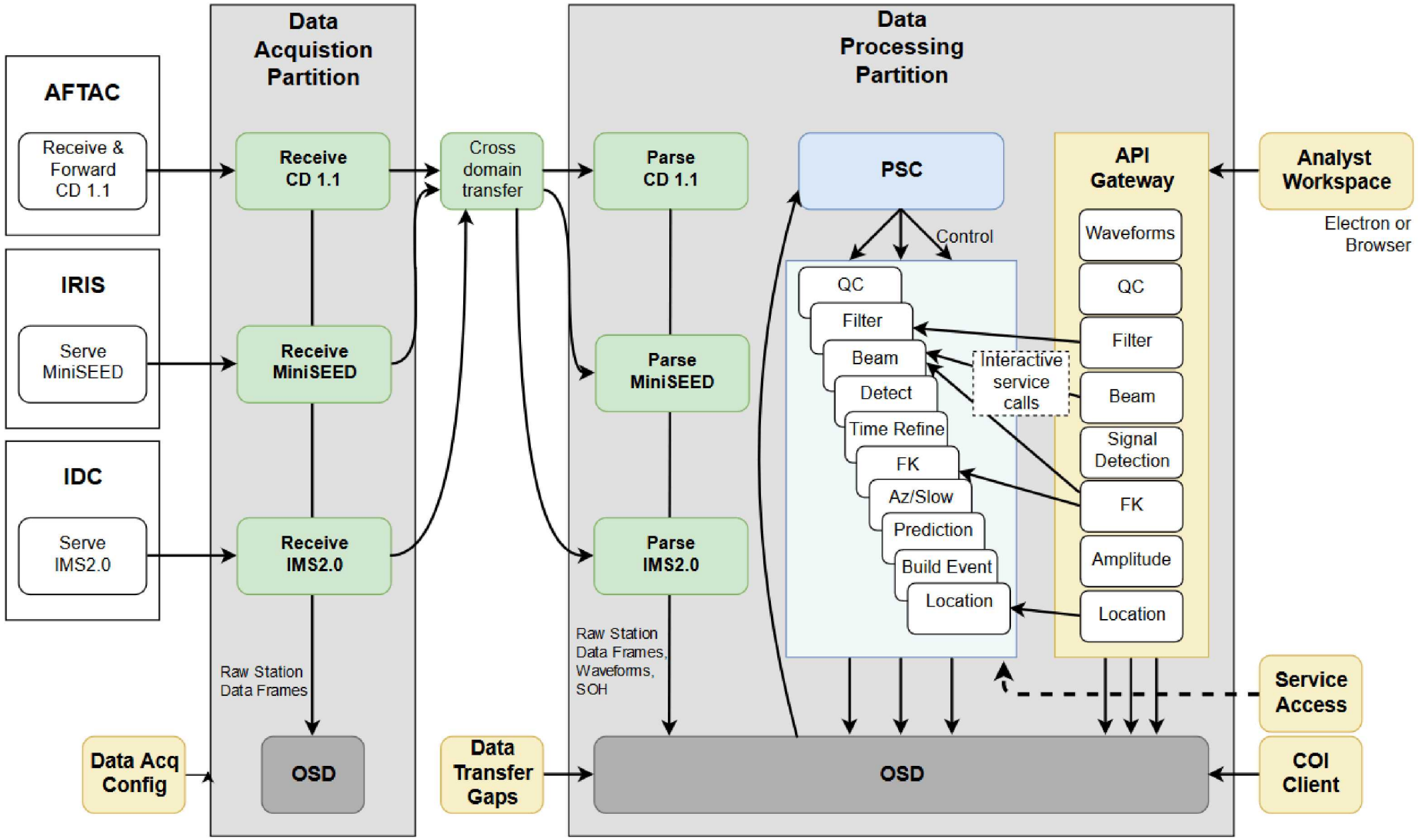
Analysis

- 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


Data Acquistion Partition
Data Processing Partition
AFTAC
Receive & Forward CD 1.1
IRIS
Serve MiniSEED
IDC
Serve IMS2.0
Receive CD 1.1
Receive MiniSEED
Receive IMS2.0
Cross domain transfer
Parse CD 1.1
Parse MiniSEED
Parse IMS2.0
PSC
Control
QC
Filter
Beam
Detect
Time Refine
FK
Az/Slow
Prediction
Build Event
Location
Interactive service calls
API Gateway
Waveforms
QC
Filter
Beam
Signal Detection
FK
Amplitude
Location
Analyst Workspace
Electron or Browser
Raw Station Data Frames
Raw Station Data Frames, Waveforms, SOH
Data Acq Config
OSD
Data Transfer Gaps
OSD
Service Access
COI Client

END