

Geophysical Monitoring System (GMS) for IDC Re-engineering



PRESENTED BY

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IDC Re-engineering and the Geophysical Monitoring System (GMS)

Analyst Workspace Examples

GMS 2019 Release



IDC Re-engineering and the Geophysical Monitoring System (GMS)

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 support from Sandia National Laboratories 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

The Geophysical Monitoring System (GMS)



Sandia National Laboratories is developing a new waveform processing system for the US National Data Center (US NDC)

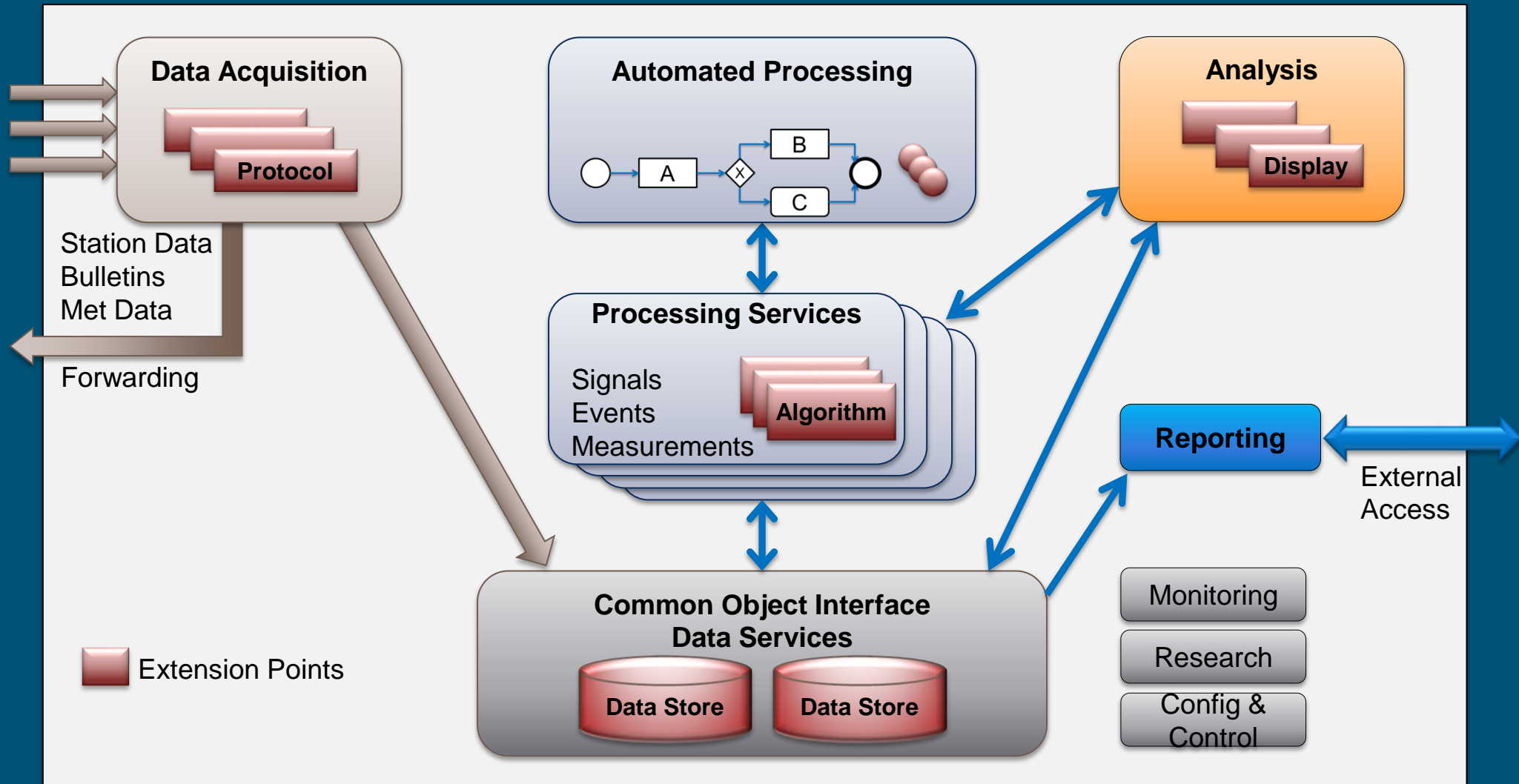
This is the **Geophysical Monitoring System (GMS)**

GMS Vision: Build a new system to meet US NDC mission requirements that improves **maintainability, extensibility, testability, etc.**

GMS executes data QC, station processing, association, event building, and bulletin generation for SHI data.



Addressing all parts of the Waveform Processing System



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)

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

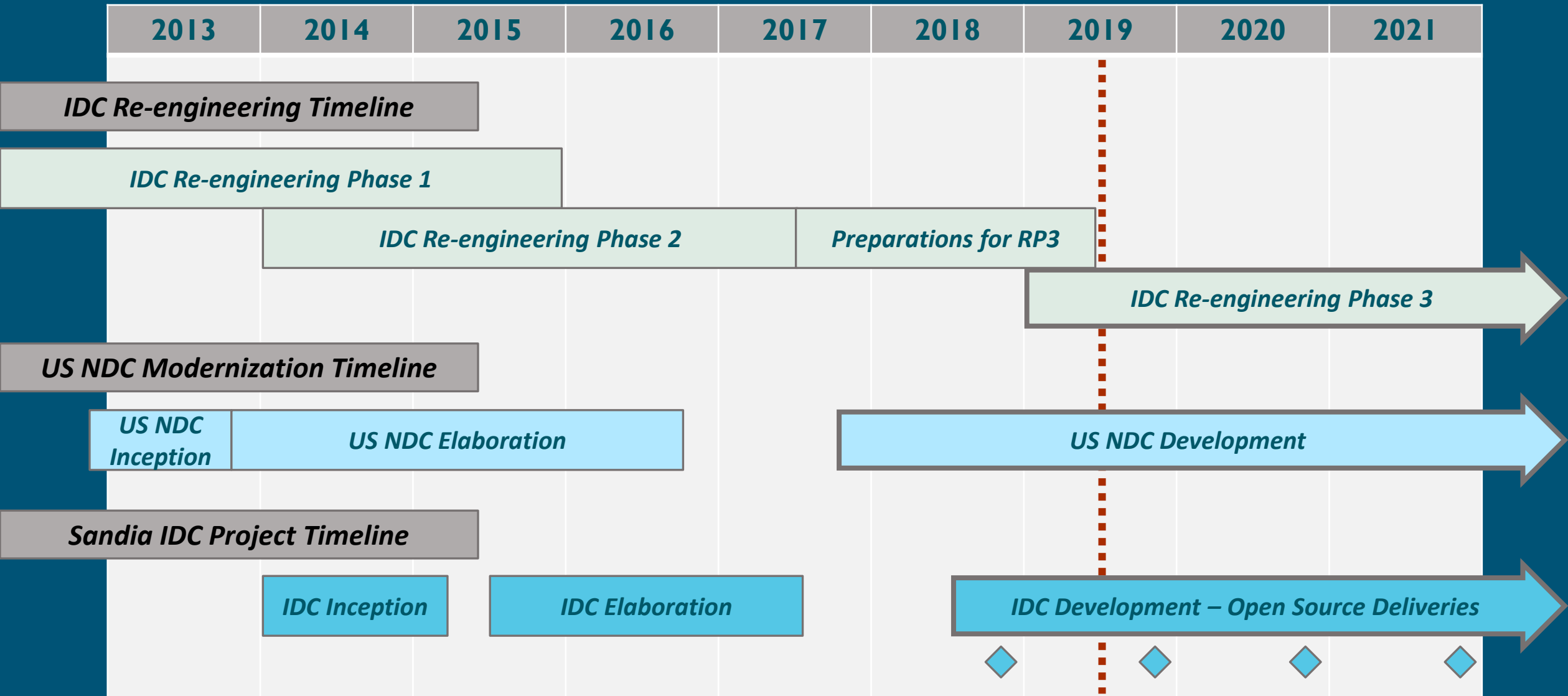
Dec 2018 – First GMS Open Source Release

- Program Increment 3 software release– very limited functionality, not buildable externally
- Released for review only

2019 – Working toward Next Release

- Generic buildable, runnable system

IDC Re-engineering Timeline





Analyst Workspace Examples



- Manages the displays used for Waveform and Event Analysis as a system
 - Workflow
 - Map
 - Waveform Display
 - Signal Detection List
 - Event List
 - 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 Displays



GMS Logs Clear stored layout

Events x Azimuth Slowness x Workflow x Map x

Complete: 0 Remaining: 50 Mark selected complete

Time ↑	#Det	Lat	Lon	Depth	Active analysts	Cx	Mark Complete
21:45:08	0	-32.183	-69.757	0.00			Mark Complete
21:51:31	0	41.399	-116.526	0.00			Mark Complete
21:51:32	2	27.733	-101.414	0.00			Mark Complete
21:54:36	0	30.043	130.965	0.00			Mark Complete
21:55:04	3	27.590	-101.373	0.00			Mark Complete
22:01:30	2	44.949	-106.384	0.00	Mark		Mark Complete
22:01:57	1	-2.628	127.166	0.00			Mark Complete
22:02:58	17	25.888	128.544	0.00	Mark		Mark Complete
22:04:50	2	40.671	-106.767	0.00			Mark Complete
22:05:42	1	67.661	20.354	0.00			Mark Complete
22:07:19	2	63.390	-146.466	0.00			Mark Complete
22:10:51	1	27.736	-101.230	0.00			Mark Complete
22:13:05	1	-34.743	-70.420	0.00			Mark Complete
22:13:51	1	37.578	-118.901	0.00			Mark Complete
22:15:39	0	36.752	-79.360	0.00			Mark Complete
22:16:36	29	9.510	-84.135	55.98	Mark		Mark Complete
22:18:26	1	63.094	-148.940	0.00			Mark Complete
22:37:29	0	-8.310	129.245	0.00			Mark Complete
22:37:35	2	21.646	143.071	301.64			Mark Complete

Map Sync with user actions Start time: 2019/02/08T00:10:59.790000 End time: 2019/02/08T00:10:59.790000

Events Stations Open Assoc. Other Assoc. Unassociated

Waveforms x

P 10 per screen Time Distance Predicted Phases: QC Masks Measure Window:

Station	Phase	Time Unc	Conflict
TXAR/fkb	P	0.685	
PDAR/fkb	P	0.902	
NVAR/fkb	P	0.685	
TORD/fkb	P	1.571	
TXAR/fkb	PcP	1.72	
PDAR/fkb	PcP	1.194	
NVAR/fkb	PcP	1.72	
ILAR/fkb	P	0.685	
EKA/fkb	P	0.685	
TORD/fkb	P	0.685	
NOA/fkb	P	0.685	

Signal Detections x Station Information x Transfer Gaps x

Open Event

Time ↑	Station	Phase	Time Unc	Conflict
22:22:12	TXAR	P	0.685	
22:24:04	PDAR	P	0.902	
22:24:24	NVAR	P	0.685	
22:25:33	TORD	P	1.571	
22:25:38	TXAR	PcP	1.72	
22:26:11	PDAR	PcP	1.194	
22:26:20	NVAR	PcP	1.72	
22:27:41	ILAR	P	0.685	
22:28:23	EKA	P	0.685	
22:29:00	TORD	P	0.685	
22:29:02	NOA	P	0.685	

20 May 2010 22:20:37.0340 + 14 minutes 28 seconds

Analyst Workspace – Customizable Layout



GMS

Station Information × Transfer Gaps × Waveforms × Workflow × Map × Azimuth Slowness ×

P 20 per screen Time Station Name Predicted Phases: QC Masks Measure Window: >>

Station	Azimuth	Phase	Filter
SIV	26.9°		unfiltered
PDAR/fkb	34.1°		unfiltered
NVAR/fkb	39.9°		unfiltered
ILAR/fkb	42.1°		unfiltered
EKA/fkb	53.0°		unfiltered
TORD/fkb	70.0°		unfiltered
NOA/fkb	77.1°		unfiltered
HFS/fkb	83.9°		unfiltered
ARCES/fkb	84.3°		unfiltered
GERES/fkb	85.7°		unfiltered
FINES/fkb	87.8°		unfiltered
AKASG/fkb	88.0°		unfiltered
PETK	91.1°		unfiltered
MMAI/fkb	97.0°		unfiltered
BVAR/fkb	98.6°		unfiltered
ZALV/fkb	108.7°		unfiltered
USRK/fkb	113.9°		unfiltered
MJAR/fkb	116.0°		unfiltered
SONM/fkb	117.3°		unfiltered
	119.3°		unfiltered
	122.0°		unfiltered

20 May 2010 22:19:18.1330 + 23 minutes 44 seconds

Show: All

Station: TXAR Channel: TX01/SHZ Phase: P

	Peak	Theoretical	Selected
Azimuth	149.036 (± 0.100)	149.036 (± 0.100)	
Slowness	0.052 (± 0.001)	0.058 (± 0.001)	
Fstat	8.811	---	---

Frequency: Custom

Low: 1.25

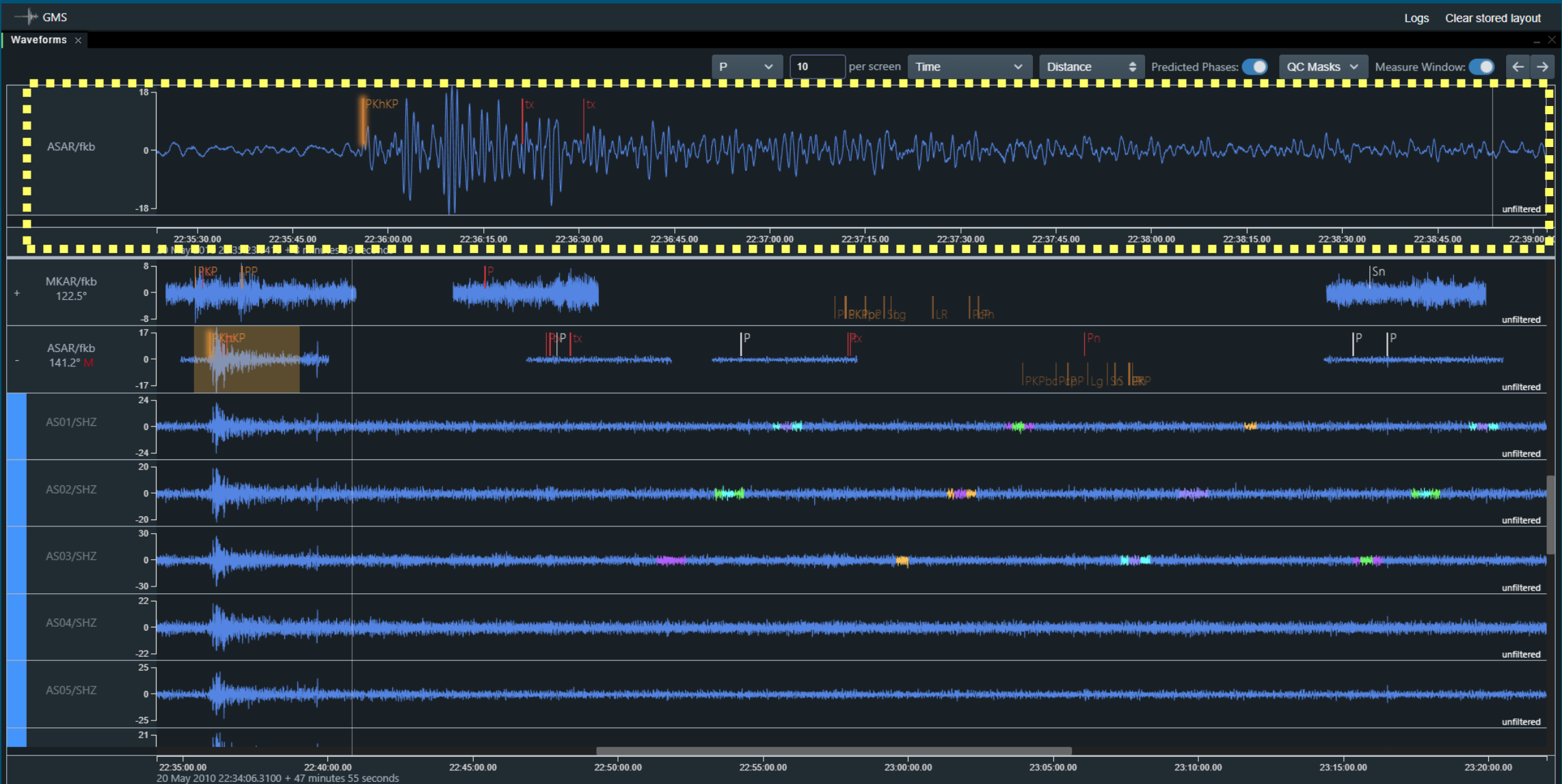
High: 3.25

Events × Signal Detections ×

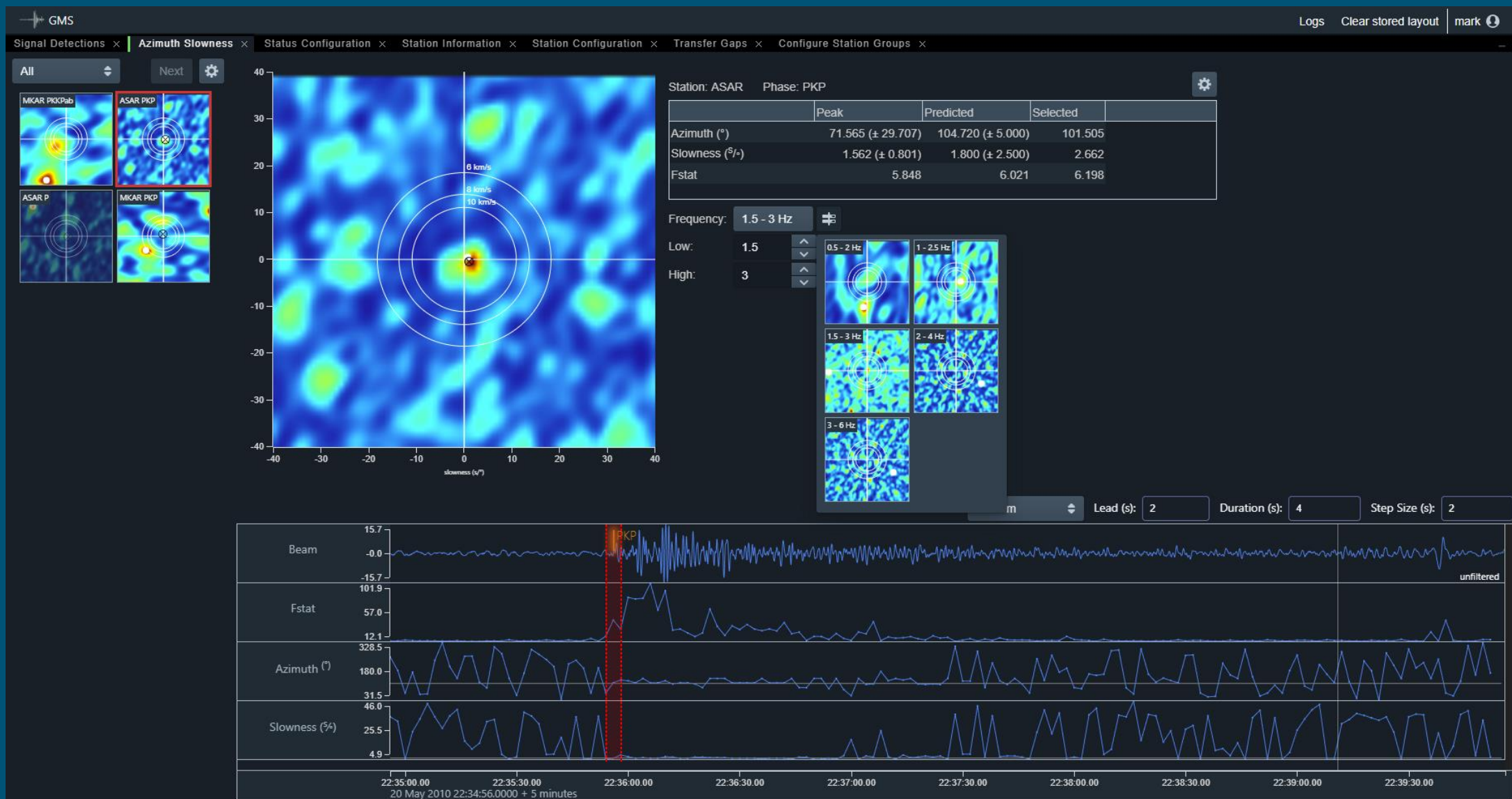
Open Event

	Time ↑	Station	Phase	Time Unc	Ct
	22:28:23	EKA	P	0.685	
	22:29:00	TORD	P	0.685	
	22:29:02	NOA	P	0.685	
	22:29:09	HFS	P	0.685	
	22:29:19	ARCES	P	0.685	
	22:29:20	GERES	P	0.685	
	22:29:35	FINES	P	0.685	
	22:30:01	AKASG	PP	0.685	
	22:33:53	AKASG	PP	1.369	

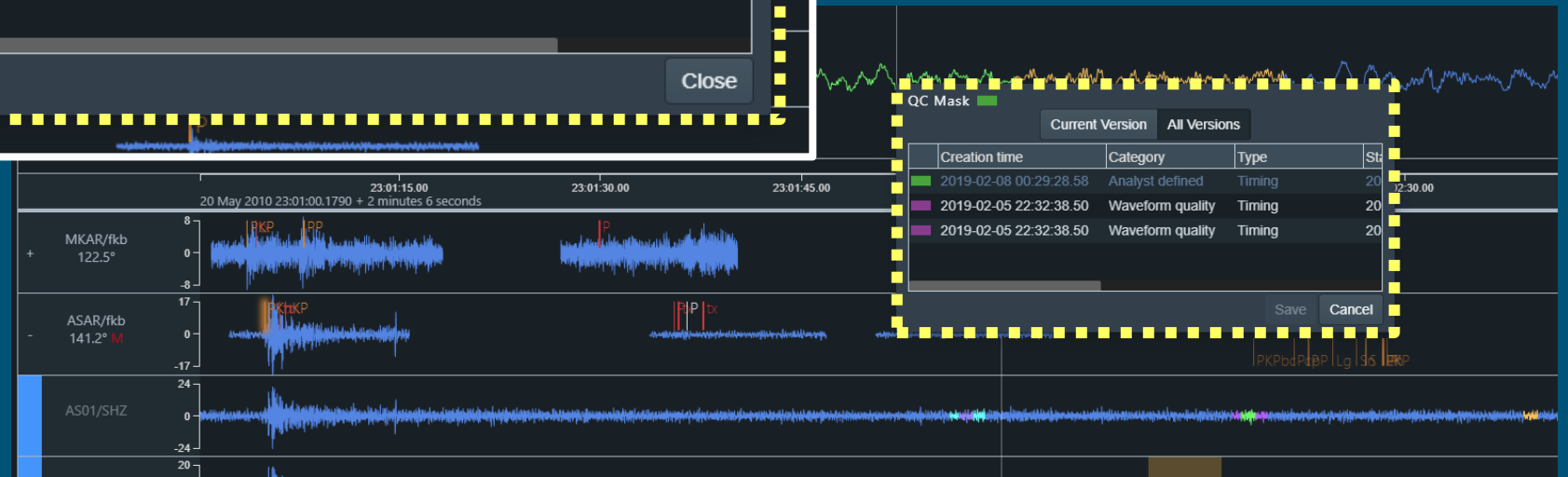
Waveform Display with new Measurement Window



Azimuth/Slowness (FK) Display



Provenance: Viewing Signal Detection and QC Mask History





GMS 2019 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
- Data Acquisition Configuration Display
- Station SOH Display

Operations

- COI Data Service

Processing

- Processing Sequence Execution - initial station processing
- Processing Sequence Configuration Display
- Waveform QC
- Linear Filtering (FIR)
- Beamforming
- Power Detector (STA/LTA)
- Onset Time Refinement (AIC)
- FK Spectra
- FK Measurements – az, slow, fstat
- Feature Prediction – 1D time, az, slow, mag 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



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
- 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

