SAND2021-7585PE

GMS Overview

PRESENTED BY

J. Mark Harris

IDC Technical Meeting on SHI Software Engineering
July 5th-6th 2021

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.

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.

SAND2021-XXXX

The Geophysical Monitoring System

Sandia National Laboratories is developing the Geophysical Monitoring System (GMS) to modernize the United States National Data Center waveform processing system, including data acquisition, automated processing, and interactive analysis.

The United States is providing the common architecture and processing components of GMS as Open Source to assist with IDC Re-engineering.

Recently GMS has focused on developing a **Station State-of-Health (SOH) Monitoring** capability, to enhance the ability of system operators to quickly recognize and address station availability and quality issues.

Latest Open Source Release Posted to GitHub in April 2021

- https://github.com/SNL-GMS/GMS-PI13-OPEN
- BSD open source license

This release includes:

- Source code for PI 13 Station SOH Monitoring capability
- User Guide & Configuration Guide
- SOH configuration for IMS networks
- Tested to build, deploy, and run in a generic environment

Station SOH Monitoring Capabilities

- Acquires CD1.1 protocol data for 300+ stations
- Computes SOH metrics, configurable for each channel and metric type:
  - Missing Data
  - Data Timeliness
  - Communications Lag
  - Station Environment Issues
- Computes roll-up statuses, configurable by station and station group:
  - Worst-of SOH status roll-up for each Station
  - Capability status roll-up for Station Groups and Stations
- Displays current status as well as selectable long-term averages and trend plots
- Stores SOH data for trend plots and to restart with stored state
- A System Messages Display shows information and provides audible alarms

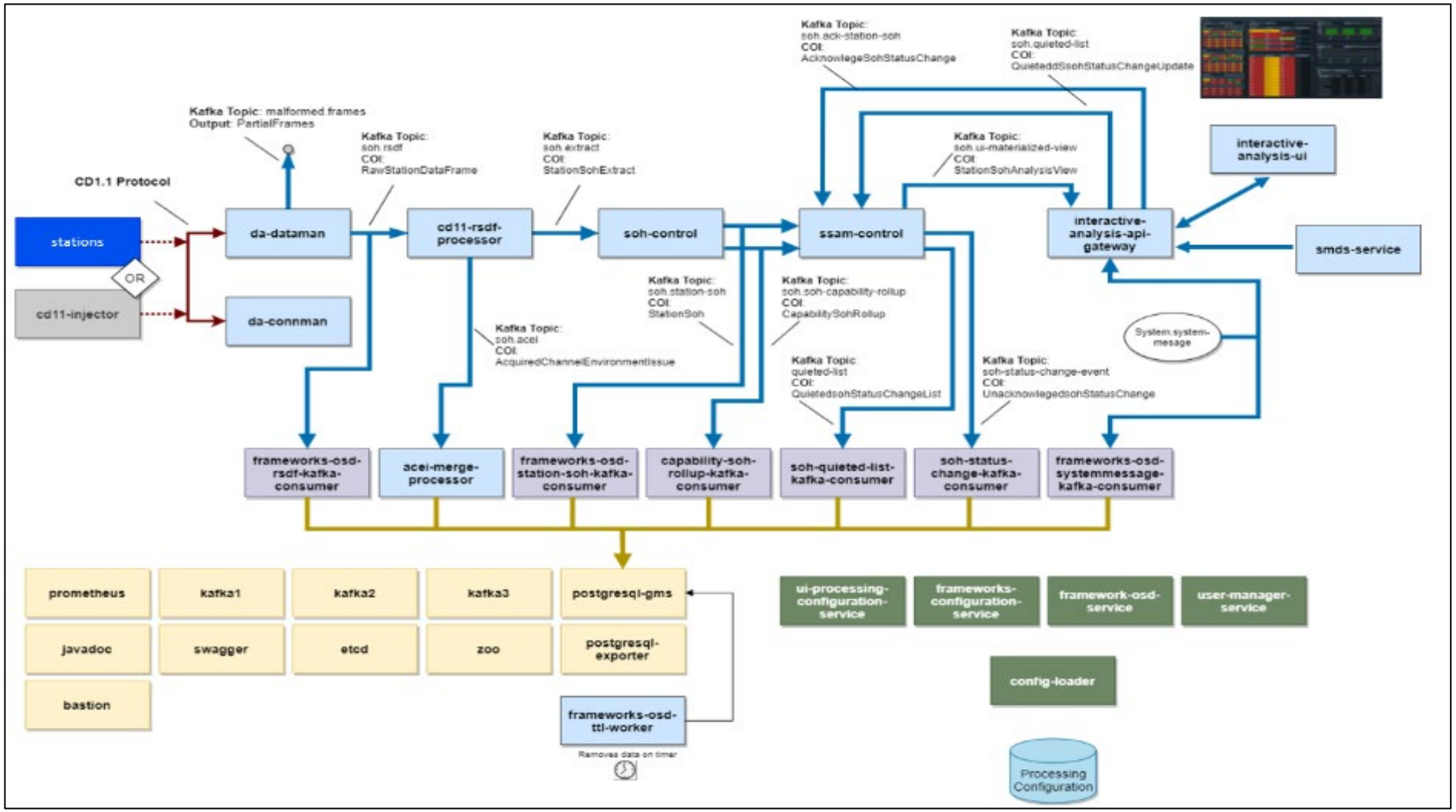
SOH Displays

- Overview Display
- Station Statistics
- Missing drill-down
- Timeliness drill-down
- Lag drill-down
- Environment
- Missing Trends
- Lag Trends
- Environment Trends
- System Messages

All SOH displays are synchronized

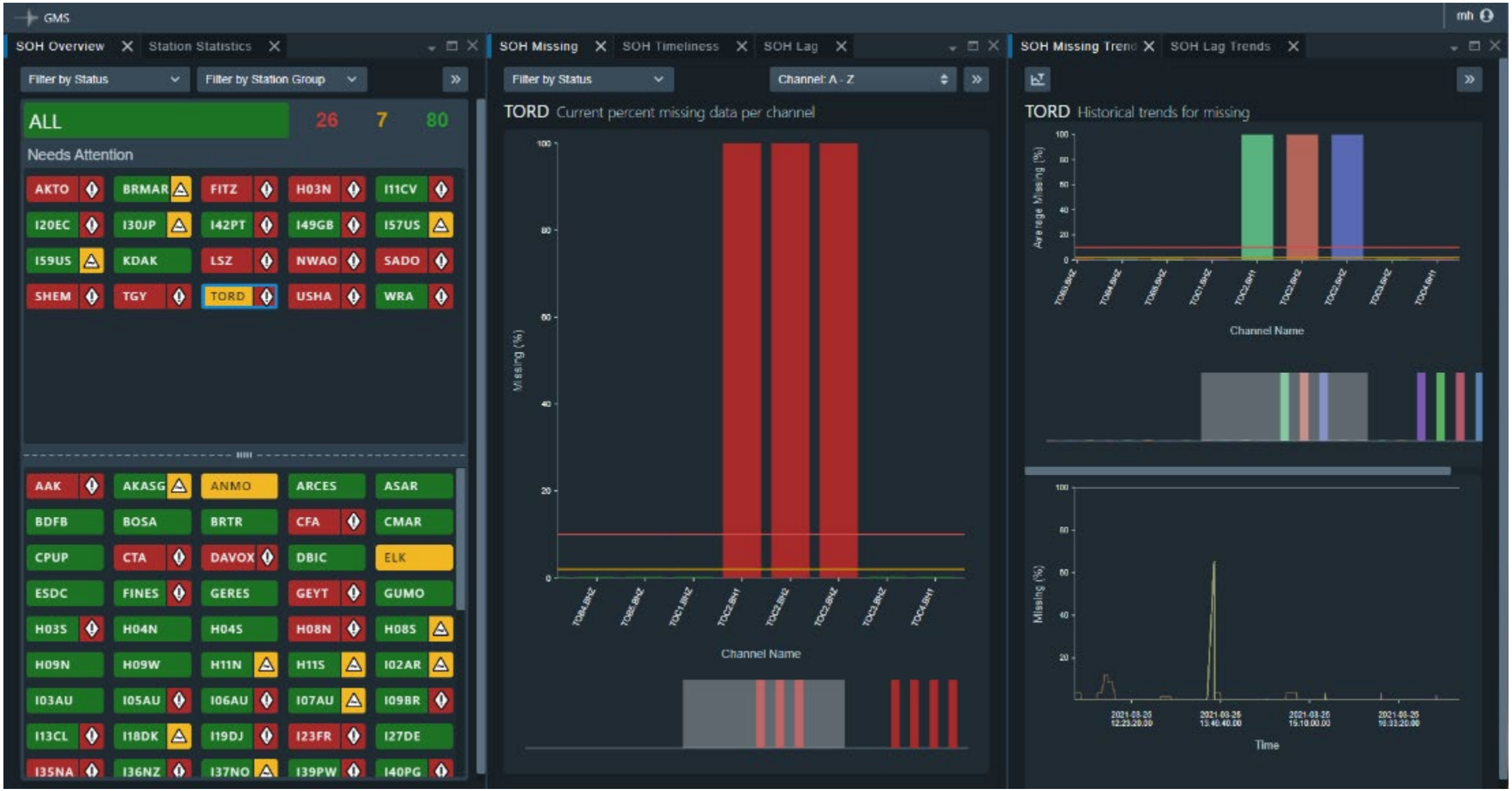
Layout is adjustable by the user

Station SOH Monitoring System

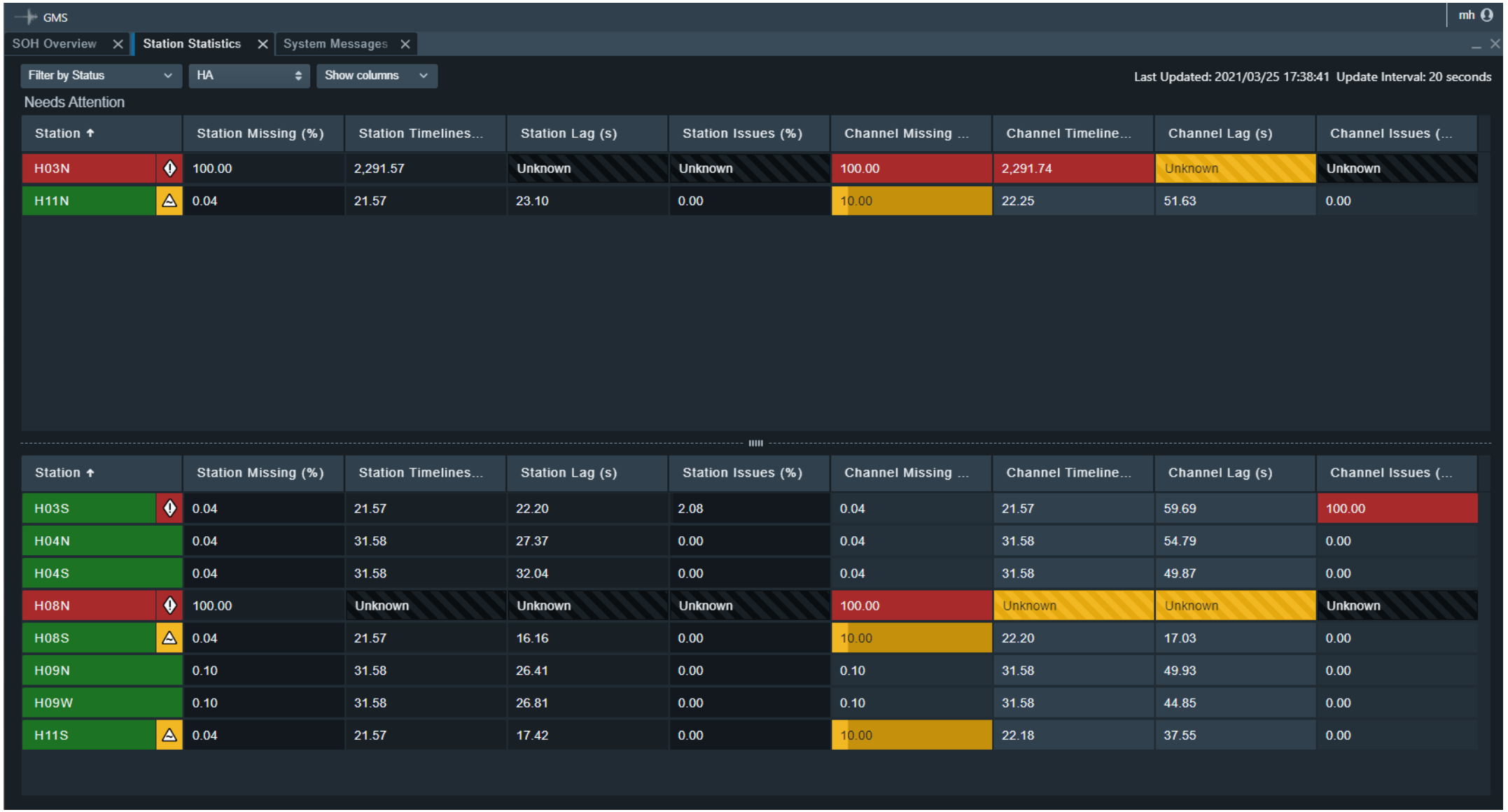


- GMS has a service-oriented architecture, using Kafka for inter-process communication.
- User interfaces are rendered in a web browser
- Languages:
  - Java (back-end)
  - Typescript (user interfaces)
  - Python (platform utilities)
- The SOH storage database is PostGRES.
- GMS is deployed in Docker containers orchestrated with Kubernetes, a common cloud environment.

SOH Workspace



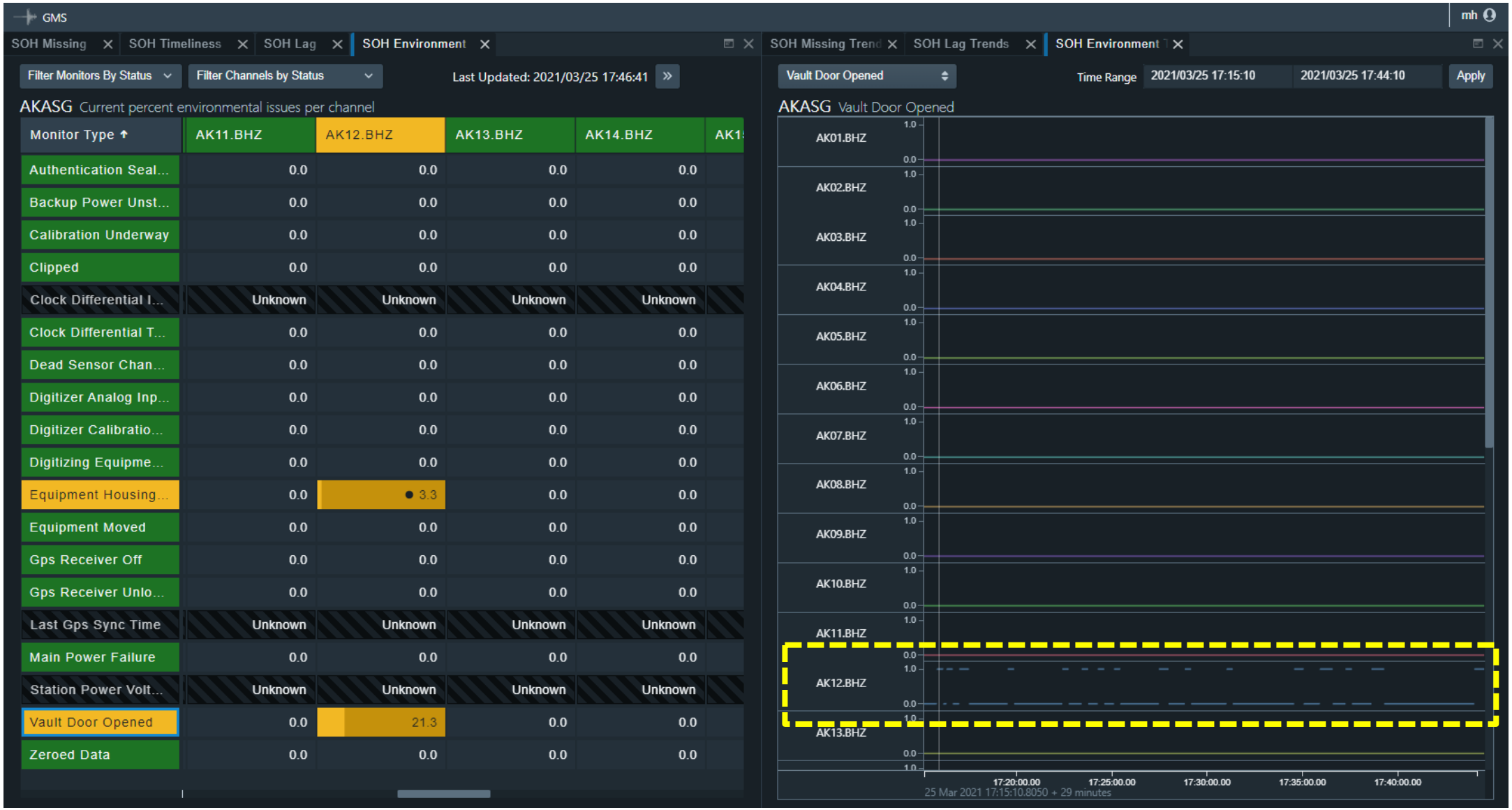
Station Statistics Display – filtered by Station Group HA



Station	Station Missing (%)	Station Timelines...	Station Lag (s)	Station Issues (%)	Channel Missing ...	Channel Timeline...	Channel Lag (s)	Channel Issues (...
H03N	100.00	2,291.57	Unknown	Unknown	100.00	2,291.74	Unknown	Unknown
H11N	0.04	21.57	23.10	0.00	10.00	22.25	51.63	0.00

Station	Station Missing (%)	Station Timelines...	Station Lag (s)	Station Issues (%)	Channel Missing ...	Channel Timeline...	Channel Lag (s)	Channel Issues (...
H03S	0.04	21.57	22.20	2.08	0.04	21.57	59.69	100.00
H04N	0.04	31.58	27.37	0.00	0.04	31.58	54.79	0.00
H04S	0.04	31.58	32.04	0.00	0.04	31.58	49.87	0.00
H08N	100.00	Unknown	Unknown	Unknown	100.00	Unknown	Unknown	Unknown
H08S	0.04	21.57	16.16	0.00	10.00	22.20	17.03	0.00
H09N	0.10	31.58	26.41	0.00	0.10	31.58	49.93	0.00
H09W	0.10	31.58	26.81	0.00	0.10	31.58	44.85	0.00
H11S	0.04	21.57	17.42	0.00	10.00	22.18	37.55	0.00

Example Drill-down: AK12.BHZ Vault Door Open



Future Development

GMS has transitioned to development of data analysis tools, including “bridge” components to access data from the legacy system database and translate to the GMS Common Object Interface (COI) format.

Routine Event Analysis Epic

- Purpose: Replace ARS functionality for routine analysis
- Routine analysis includes:
  - analysis functions to create data for a consistent event bulletin
  - processing services as needed by the GMS UI
  - data bridge components to the legacy system
  - interfaces exposing legacy data in COI format
- Developed incrementally with operational quality
- Still early in development

Capabilities* of the Routine Event Analysis Epic

Event Review

- Waveform Viewing
- Analysis Interval Selection
- Signal Detection Viewing

Current Increment

- Event Viewing
- QC Mask Viewing
- Waveform Filtering
- Undo/Redo Stack
- QC Mask Editing
- Waveform Beamforming
- Signal Detection Editing
- Event Editing
- Basic Event Save
- Analysis Interval Management

Event Refinement

- FK (basic and dynamic)
- Waveform Rotation
- Amplitude Measurement
- Event Location
- Event Magnitude
- Interactive GA
- Manage Late Arriving Data
- Long-Period Analysis Mode

Scan

- Waveform Scan Mode
- Unassociated Detection Scan Mode

Initial Analysis

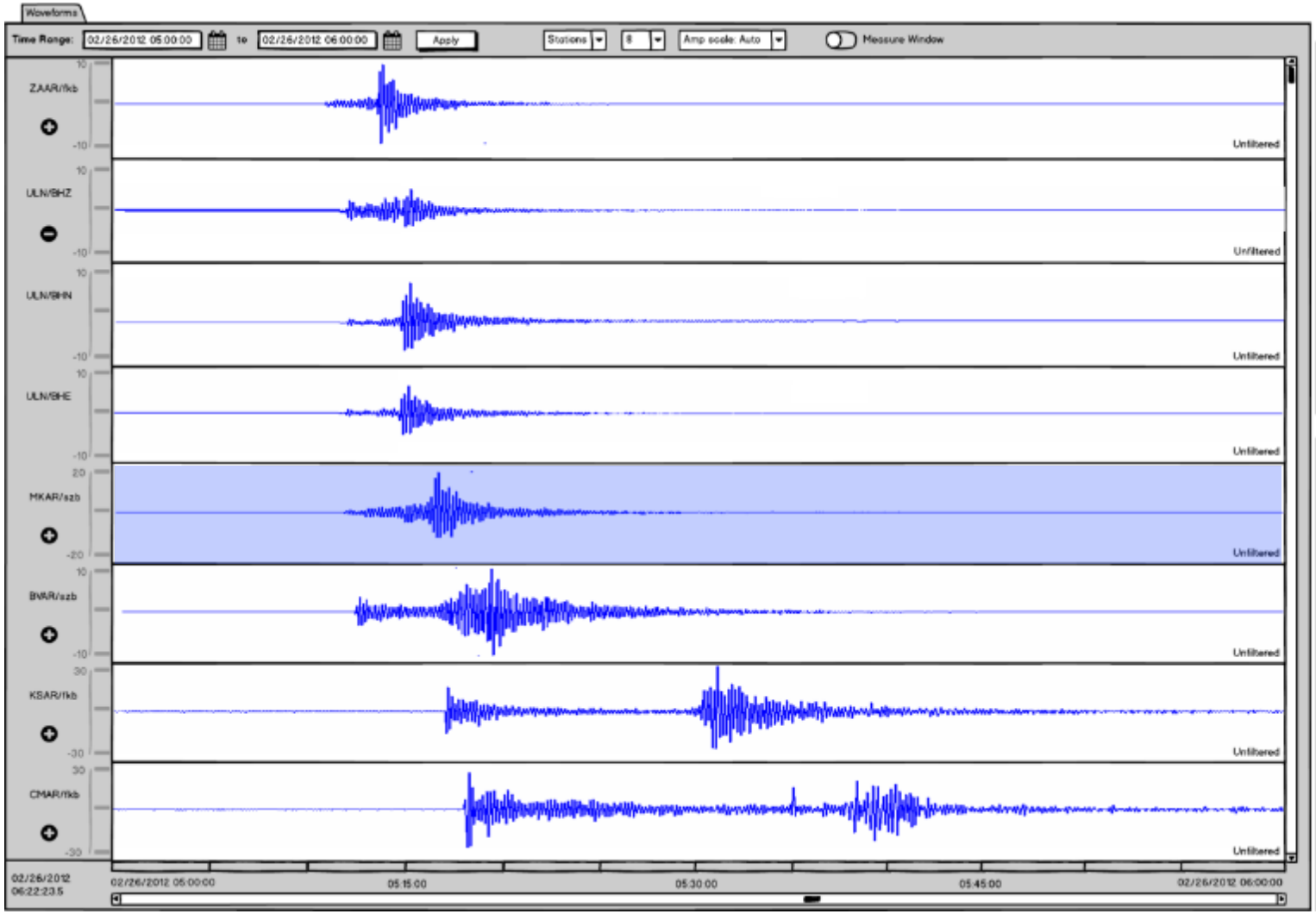
- Hydroacoustic Analysis Mode
- GIS Layers on Map
- Waveform Correlation
- Spectrogram

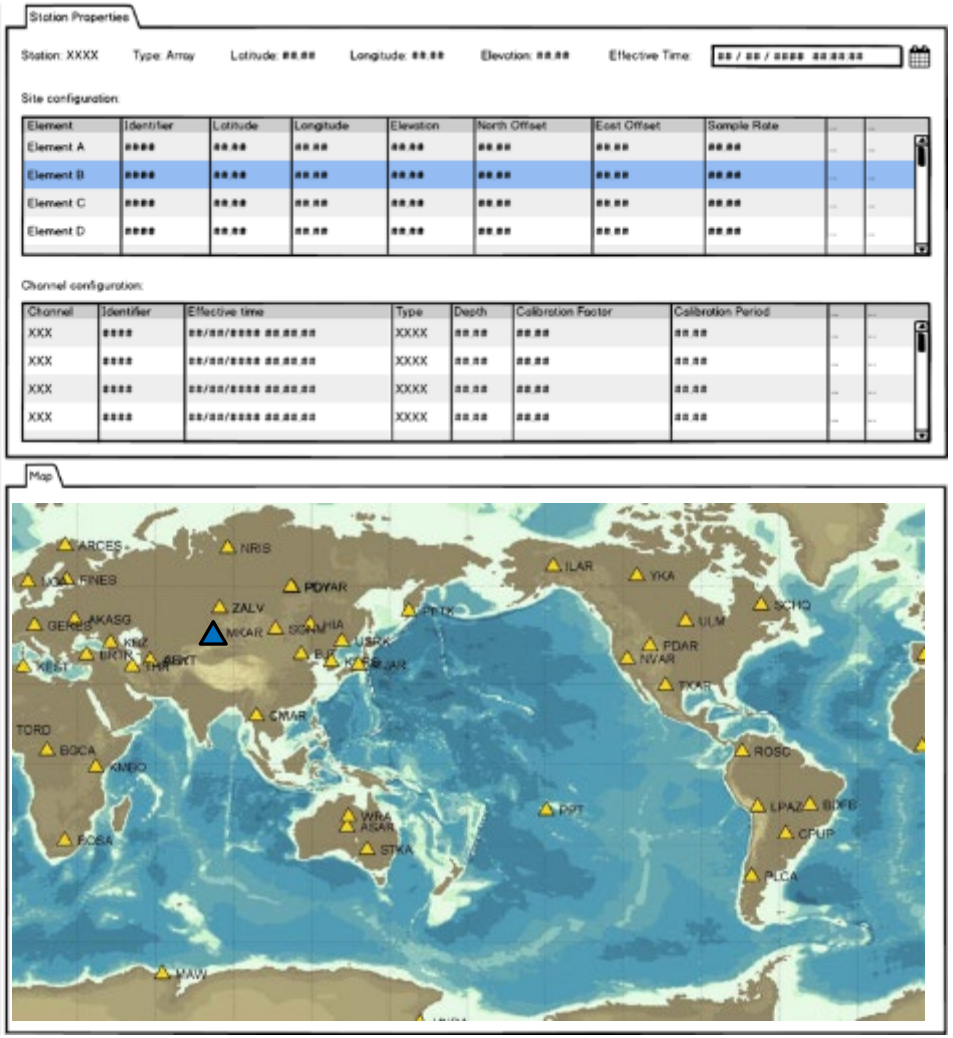
Full Analysis

- Event History
- Event Comparison
- Analyst Feedback
- Operations Log
- Analysis Sequence Configuration Display

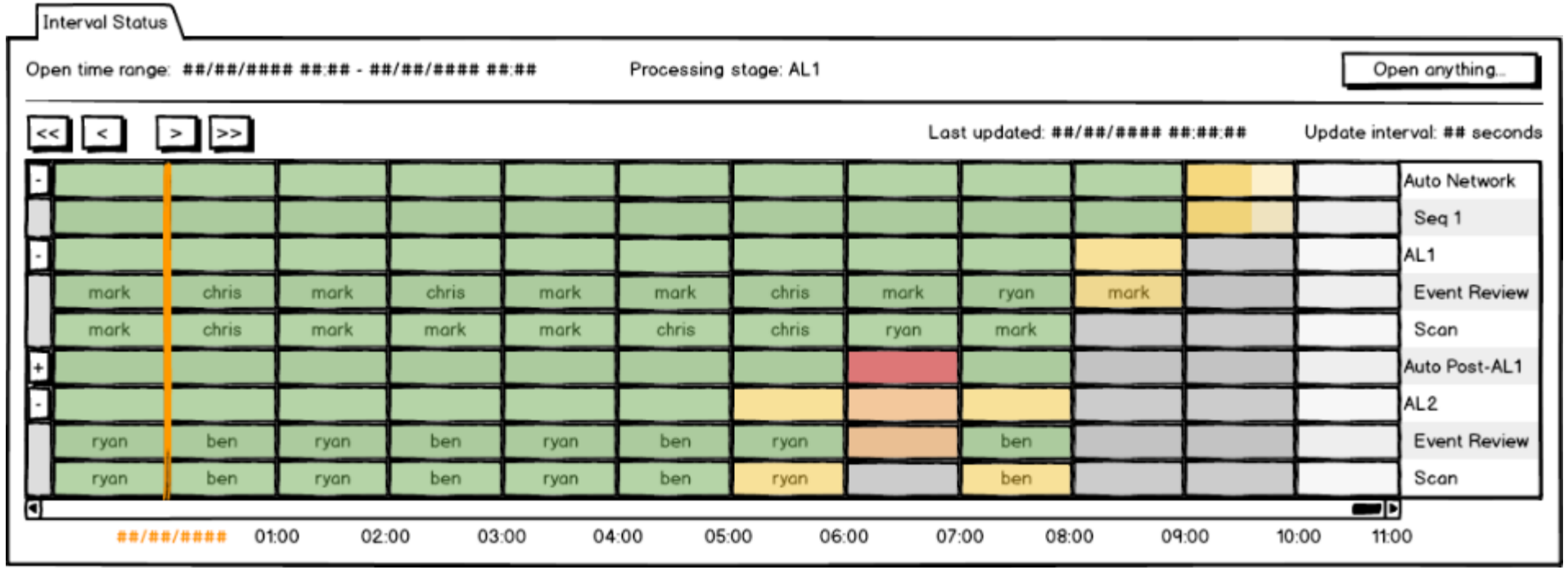
* Iteratively defined and planned

Waveform Viewing Capability

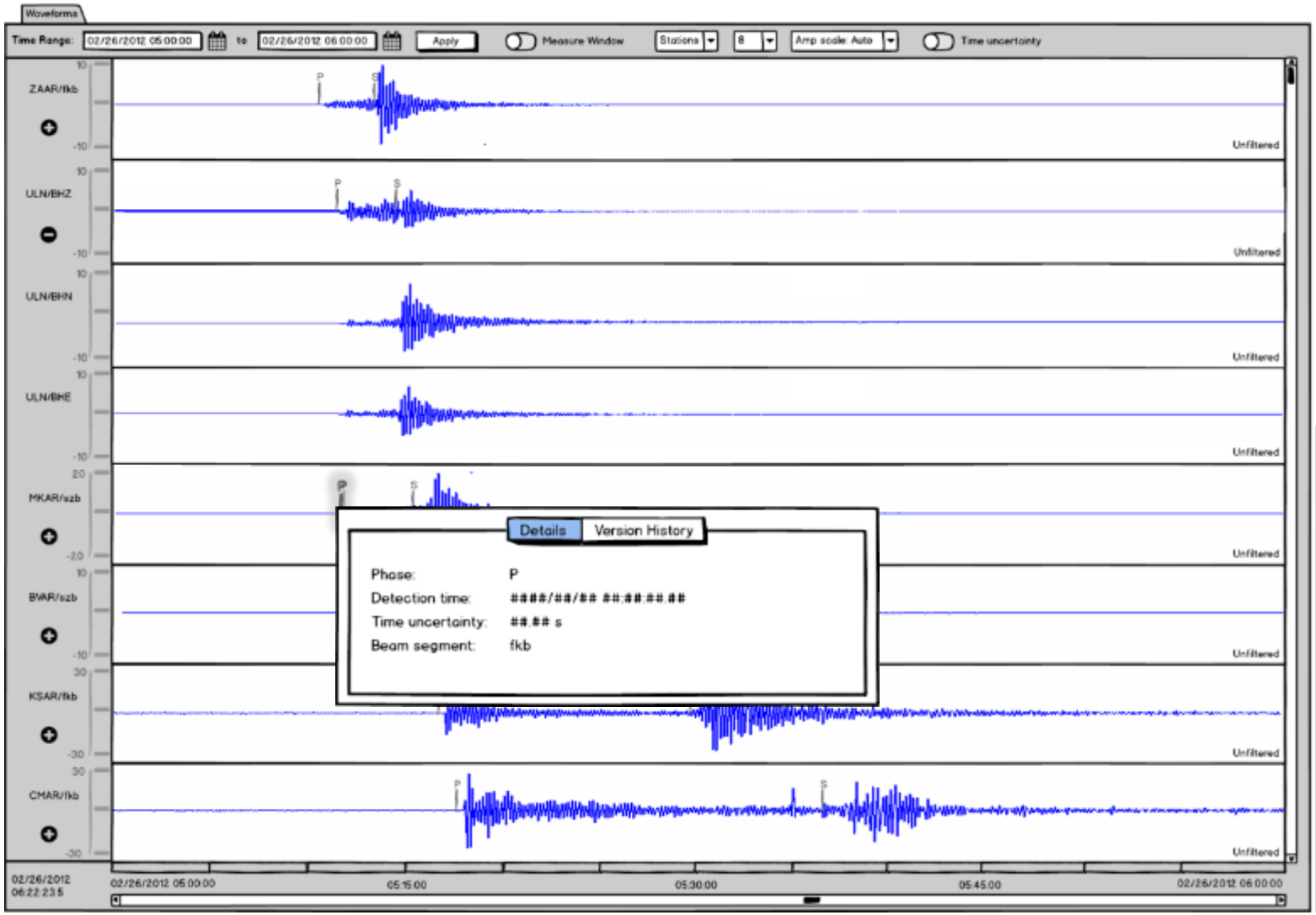


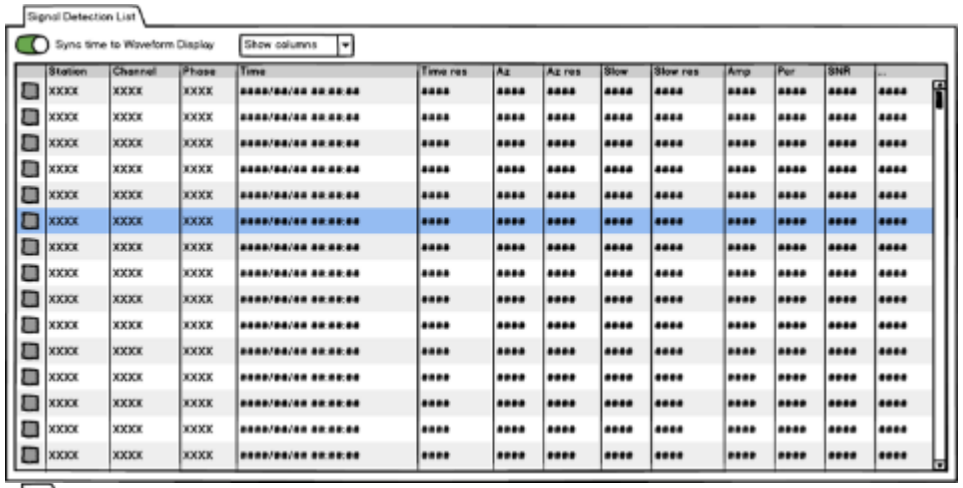


Interval Selection Capability



Signal Detection Viewing Capability





Next GMS Open Source Release

Planning to release the current program increment – PI 16

- Development closes August 2021
- Release posted December 2021

Expected Functions Included:

- Station SOH Monitoring
  - New - Timeliness Trends drill-down
  - New - Map
- Analysis Displays
  - Analysis Interval Selection
  - Station Properties
  - Waveforms
  - Map w/ stations
  - *No Signal Detections are shown in UI yet*
- Bridge Components (read only)
  - Station Information
  - Waveforms
  - Intervals
  - Signal Detections (basic attributes)

Questions?