SAND2023-04942D

SnT 2023
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
HOFBURG PALACE - Vienna and Online
19 TO 23 JUNE

Geophysical Monitoring System (GMS) Interactive Analysis Capabilities

Mark Harris, Katherine Aur, Nicole McMahon,
KJ Lechtenberg, Paul Wright
Sandia National Laboratories

Sandia National Laboratories

INTRODUCTION

Sandia National Laboratories is developing the Geophysical Monitoring System (GMS) for the US NDC, focused on Interactive Analysis tools, and releasing GMS as open source to assist IDC Re-engineering.

METHODS/DATA

GMS is a large, agile software development project, using GitLab CI/CD development pipelines, deployed in a cloud-ready Kubernetes containerized platform.

START

RESULTS

GMS is a service-oriented, distributed web application. Interactive Analysis (IAN) includes displays for the base data types needed for SHI analysis. IAN uses modern web technology, accessed with a common web browser, with consistent, flexible, fully synchronized displays

CONCLUSION

SNL is developing GMS data access services and an Interactive Analysis application, planned to complete in 2026. GMS is cloud-ready, operational quality, and secure. We are releasing two GMS Open Source versions per year.

Please do not use this space, a QR code will be automatically overlayed

P4.4-325

Sandia National Laboratories
U.S. DEPARTMENT OF ENERGY NNSA
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.

Introduction

Sandia National Laboratories (SNL) is developing the Geophysical Monitoring System (GMS) for modernization of the United States National Data Center (US NDC) waveform processing system.

The United States is providing the common architecture and processing components of GMS as a contribution-in-kind to accelerate progress on International Data Centre (IDC) Re-engineering.

Open source releases of GMS, available on GitHub, have been made annually since 2018.

Recently the GMS development effort is focused on interactive analysis capabilities, referred to as IAN. The 2022 GMS open source release includes capabilities to access and display station metadata, waveforms, QC masks, signal detections, and events. IAN uses modern web technology, accessed with a common web browser. All displays are fully synchronized with a consistent user experience.

The latest release also includes a mature, operational-quality Station State-of-Health (SOH) Monitoring capability for CD-1.1 protocol stations, to enhance the ability of system operators to quickly recognize and address station availability and quality issues.

GMS is deployed using a cloud-ready Kubernetes containerized platform, hardened for cyber security accreditation.

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Objectives

The US NDC and IDC systems originated from 1990's technology and over time have become difficult to maintain and enhance. Both systems are in need of modernization.

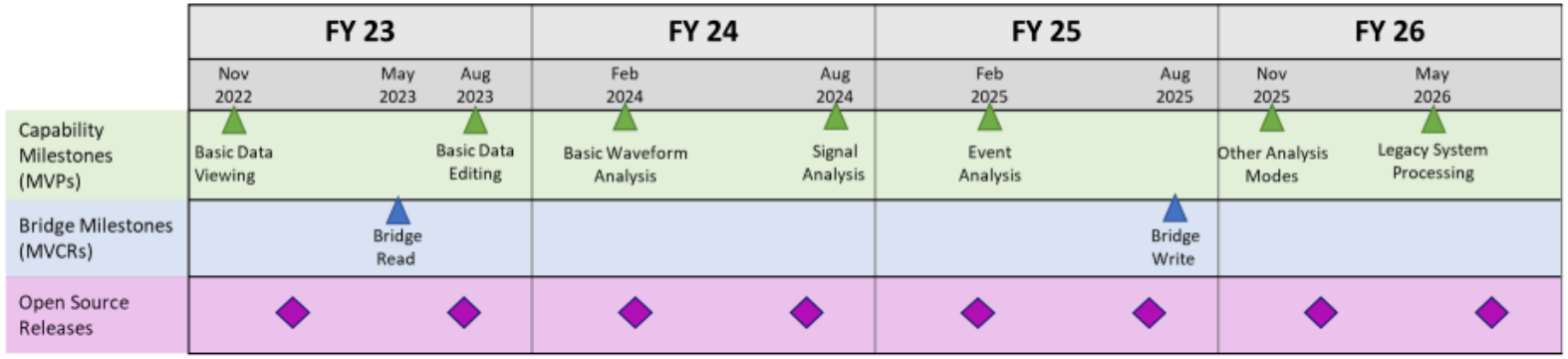
SNL has been working with the US NDC and IDC to establish requirements, design new software architectures, and develop modern processing and analysis software. A primary objective is to improve system qualities such as extensibility, maintainability, configurability, usability, and security.

GMS development is now focused on developing interactive analysis tools used by seismic, hydroacoustic, and infrasound analysts, with the goal to replace the Analyst Review Station (ARS) software with a modern, efficient, and extensible system.

This effort includes development of data services that "bridge" the data from the legacy system to the GMS Common Object Interface format and make this data available through web services to GMS applications and external users.

SNL is developing GMS for the US NDC modernization effort, and providing two open source software releases per year for use in IDC Re-engineering.

Interactive Analysis Development Milestones



INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

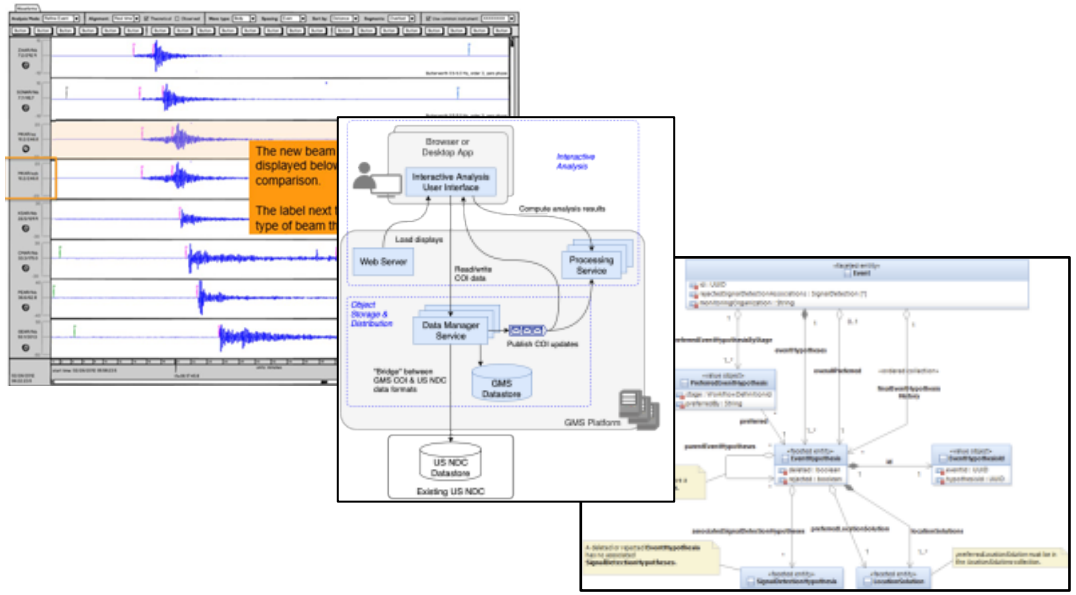
Please do not use this space, a QR code will be automatically overlayed

Methods

Product Design and Architecture

GMS is a large software development project with several development teams, plus architecture, geoscience, platform, and test teams.

Product Management defines and prioritizes a capability roadmap, and along with user experience and architecture develops product guidance for developers in the form of descriptions, storyboards, and architecture designs.

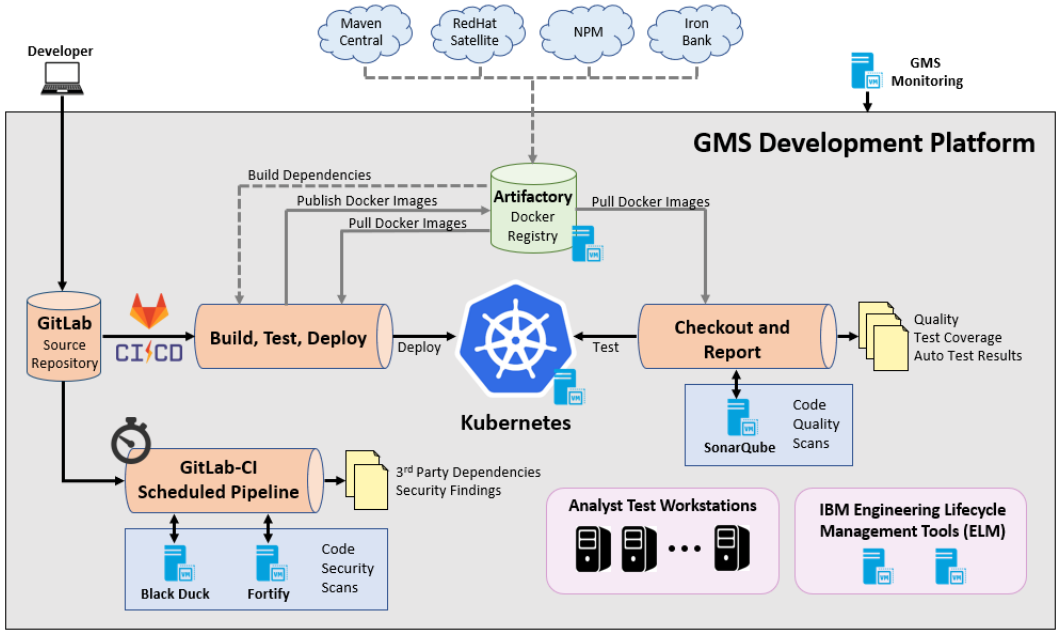


Development and Deployment

GMS uses agile development practices, working in two week iterations. GMS developers manage code and workflow in GitLab.

We use GitLab Continuous Integration / Continuous Deployment (CI/CD) to automate software build, test, and deployment pipelines.

GME is deployed using a cloud-ready Kubernetes containerized platform, hardened for cyber security accreditation.

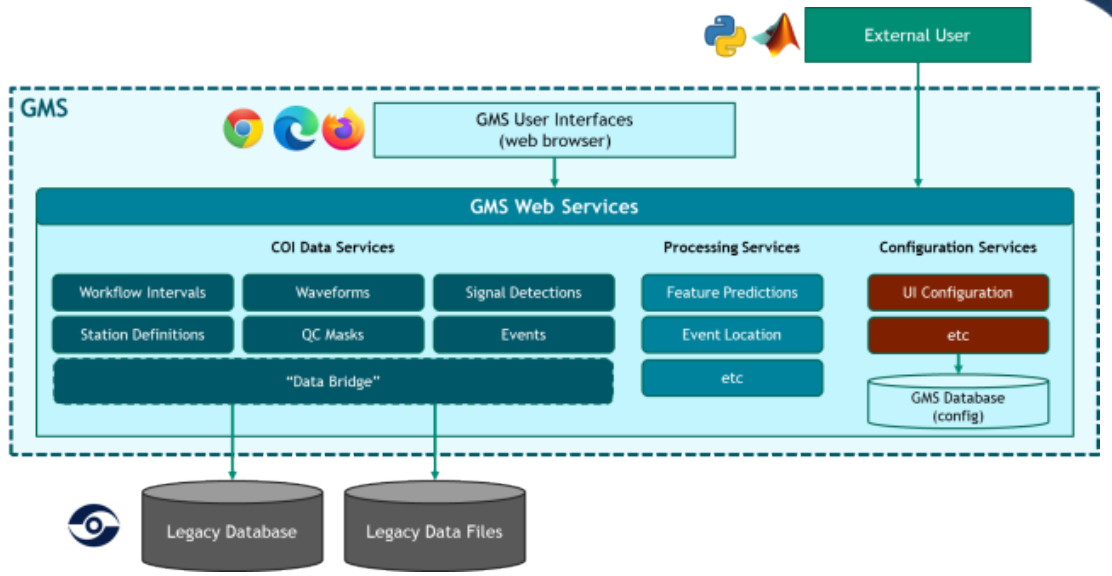


INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Please do not use this space, a QR code will be automatically overlayed

Results
Interactive Analysis (IAN)

GMS is a service-oriented, distributed web application. Data services provide access to stored data (in this case from the legacy database) to GMS applications like IAN. Processing and configuration services also support analysis operations. External users can also access these services.



IAN can currently display the base data types needed for SHI analysis. Displays include Workflow, Station Properties, Waveforms, Filters, Signal Detection List, Event List, Map, Undo/Redo. Capabilities to edit data and perform signal processing operations are underway.

IAN uses modern web technology, accessed with a common web browser. Display are flexible and customizable. Data and user operations are fully synchronized across all displays, with consistent user experience design.

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

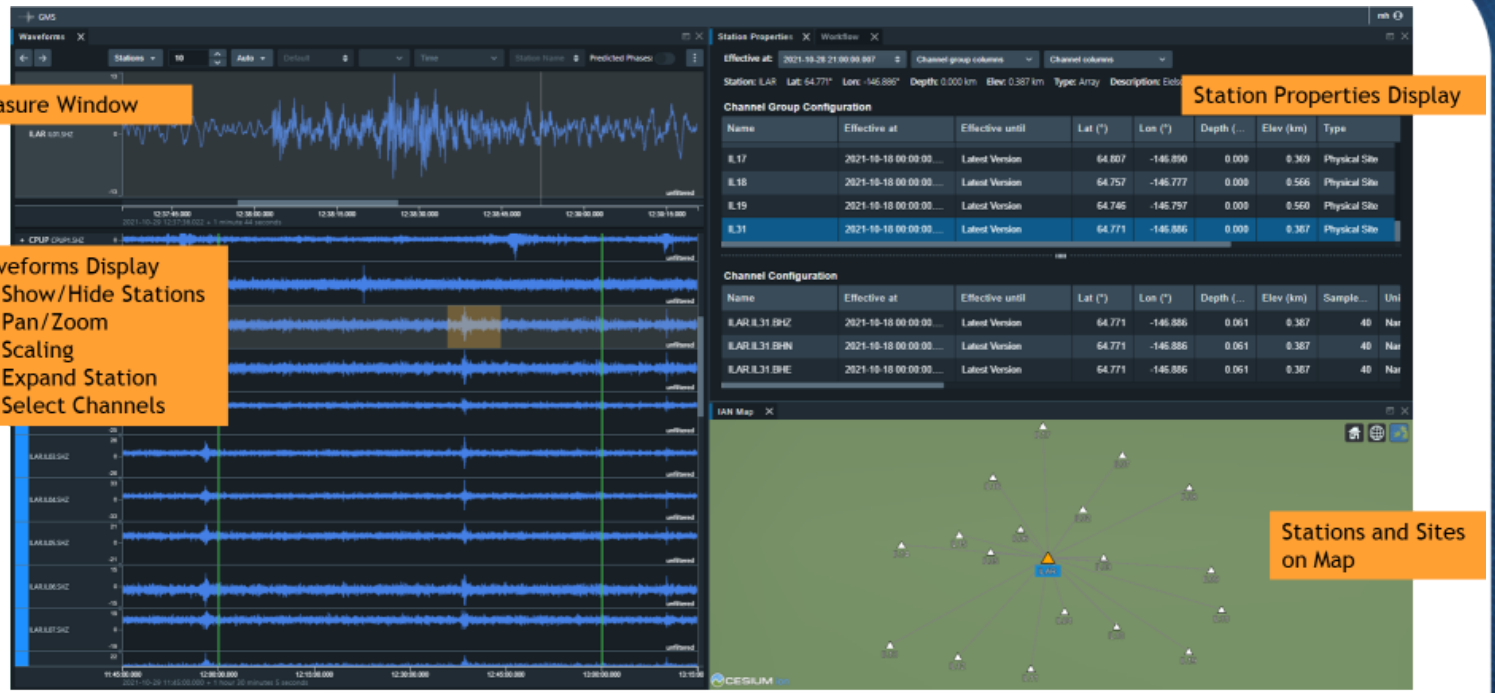
Please do not use this space, a QR code will be automatically overlayed

Results
Station and Waveform Analysis Features

Station Viewing
- Map – station and site icons
- Station Properties – text attributes for stations, site, channels
- Waveform Display – show and hide stations

Waveform Viewing
- Beams and Raw Waveforms
- Zoom and pan
- Amplitude scaling
- Interactive QC masks
- Measure Window (zoomed waveform segment)

Waveform Analysis (next release)
- Edit QC masks
- Waveform Filtering



Station information and Waveforms bridged from the legacy database

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Please do not use this space, a QR code will be automatically overlayed

Results
Signal Detection Analysis Features

Signal Detection Viewing

- Color-coded based on association status
- Signal Detection List – text attributes
- Waveform Display – phase marker, arrival time, uncertainty
- Map – great circle path

Signal Detection Editing (next release)

- Create and reject
- Change arrival time (drag & drop)
- Change time uncertainty
- Change phase label
- View signal detection association conflicts

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Results
Event Analysis Features

Event Viewing

- Color-coded based on review status
- Event List – text attributes, workflow progress
- Map – location and uncertainty ellipse
- Waveform Display – zoom/align/sort for open event
- Waveform Display – travel time predictions

Event Editing (next release)

- Create, duplicate, reject
- Associate or disassociate Signal Detections
- View event association conflicts

Please do not use this space, a QR code will be automatically overlayed

Results
Station State-of-Health Monitoring

The latest GMS release also includes a mature, operational-quality Station State-of-Health (SOH) Monitoring capability for CD-1.1 protocol stations, to enhance the ability of system operators to quickly recognize and address station availability and quality issues.

The US NDC is now deploying this application operationally and the IDC is assessing its capabilities for their operations.

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Conclusion

SNL is developing the GMS for the US NDC, currently focusing on data access services and an Interactive Analysis application to replace ARS. This effort is planned to complete in 2026.

GMS is cloud-ready, operational quality, and secure.

The United States is providing two GMS Open Source software releases per year as a contribution-in-kind for use by IDC Re-engineering.

The current release is available on GitHub:

- https://github.com/SNL-GMS/GMS-PI21-OPEN

The next release should be available early fall 2023, including:

- Final Station SOH Monitoring application
- Significant bridged data access capability
- Early Event Analysis capability

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION