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Station state-of-health monitoring with the Geophysical Monitoring System (GMS)

J. Mark Harris, Sandia National Laboratories

P4.4-152

POSTER

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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 a contribution-in-kind to accelerate progress on International Data Centre (IDC) Re-engineering.
- Recently the GMS project 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.

GMS
Geophysical Monitoring System

- The GMS Station State-of-Health (SOH) Monitoring capability was provided to the IDC in April 2021.

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

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Station SOH Monitoring

- The GMS Station SOH Monitoring application
  - will receive, process, and display SOH information,
  - supports at least 300 stations using the CD-1.1 protocol, and
  - meets operational performance, deployment, and reliability specifications.

- Allows users to
  - view current network and station SOH status,
  - be notified of changes in station status,
  - acknowledge their awareness of station status to other users, and
  - drill down to view detailed SOH metrics to the channel level for each station.

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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

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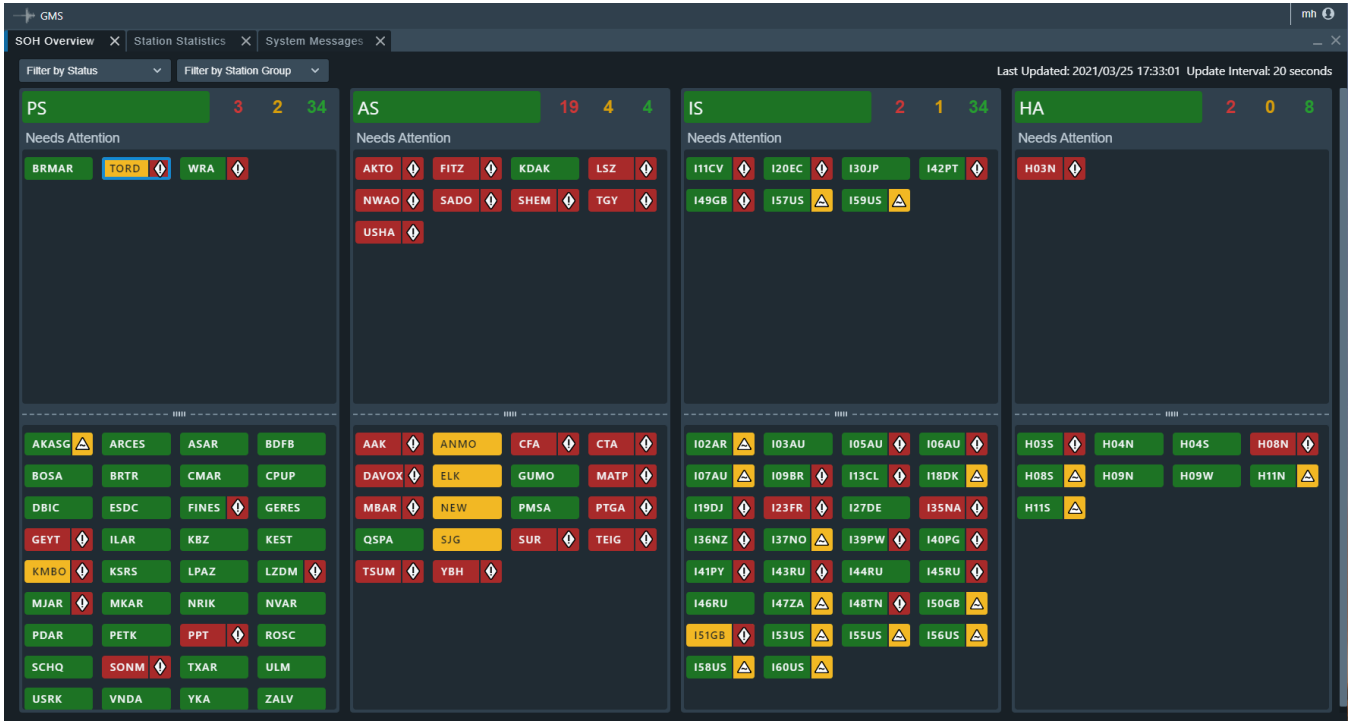
SOH Overview Display



The SOH Overview Display shows the current status of IMS stations organized by Station Group (network).

The colors of the station icons indicate the mission capability for the station. The badges attached to each station indicate the worst-of status. Both are separately configurable.

Changes to SOH status are elevated to the “Needs Attention” box for each group (upper panels) until an operator acknowledges the change by dragging the station back to the lower box.

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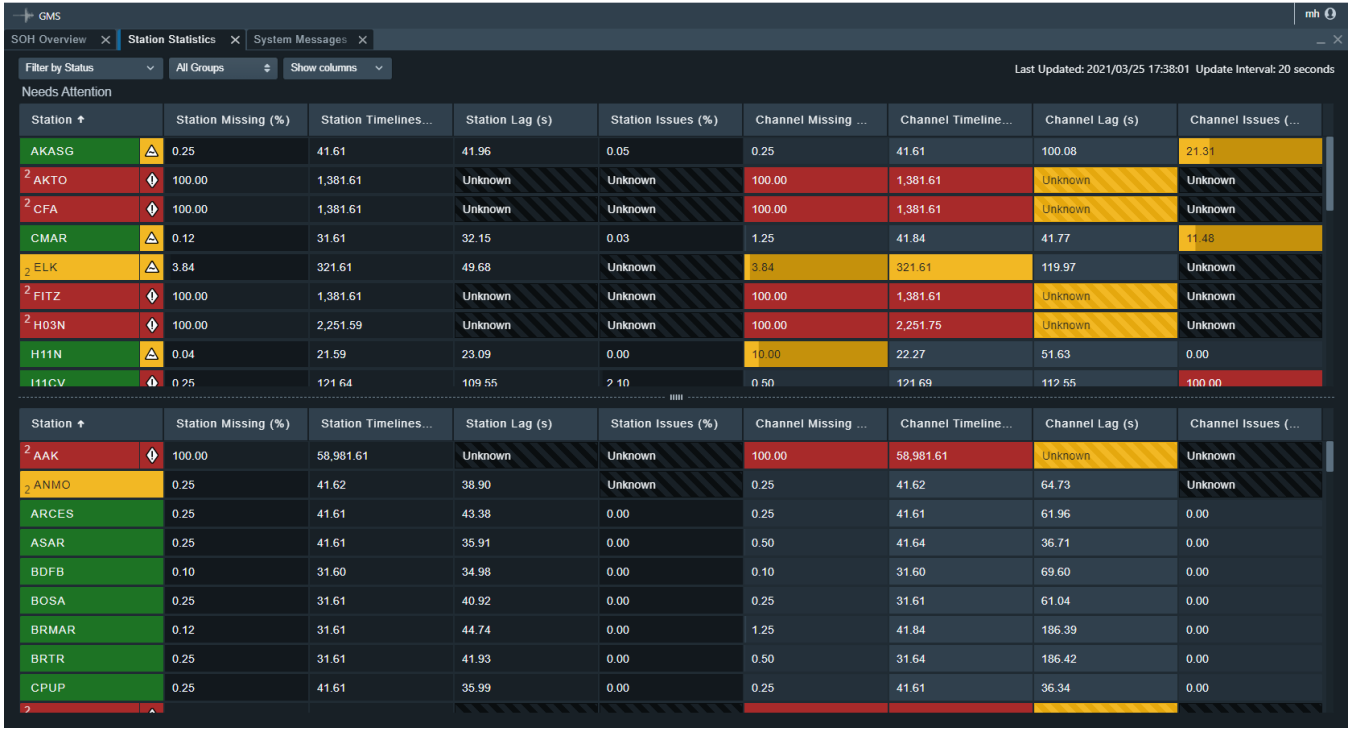
Station Statistics Display



Station	Station Missing (%)	Station Timelines...	Station Lag (s)	Station Issues (%)	Channel Missing ...	Channel Timeline...	Channel Lag (s)	Channel Issues (...
AKASG	0.25	41.61	41.96	0.05	0.25	41.61	100.08	21.31
2 AKTO	100.00	1,381.61	Unknown	Unknown	100.00	1,381.61	Unknown	Unknown
2 CFA	100.00	1,381.61	Unknown	Unknown	100.00	1,381.61	Unknown	Unknown
CMAR	0.12	31.61	32.15	0.03	1.25	41.84	41.77	11.48
2 ELK	3.84	321.61	49.68	Unknown	3.84	321.61	119.97	Unknown
2 FITZ	100.00	1,381.61	Unknown	Unknown	100.00	1,381.61	Unknown	Unknown
2 H03N	100.00	2,251.59	Unknown	Unknown	100.00	2,251.75	Unknown	Unknown
H11N	0.04	21.59	23.09	0.00	10.00	22.27	51.63	0.00
I11CV	0.25	121.64	109.55	2.10	0.50	121.69	112.55	100.00

Station	Station Missing (%)	Station Timelines...	Station Lag (s)	Station Issues (%)	Channel Missing ...	Channel Timeline...	Channel Lag (s)	Channel Issues (...
2 AAK	100.00	58,981.61	Unknown	Unknown	100.00	58,981.61	Unknown	Unknown
2 ANMO	0.25	41.62	38.90	Unknown	0.25	41.62	64.73	Unknown
ARCES	0.25	41.61	43.38	0.00	0.25	41.61	61.96	0.00
ASAR	0.25	41.61	35.91	0.00	0.50	41.64	36.71	0.00
BDFB	0.10	31.60	34.98	0.00	0.10	31.60	69.60	0.00
BOSA	0.25	31.61	40.92	0.00	0.25	31.61	61.04	0.00
BRMAR	0.12	31.61	44.74	0.00	1.25	41.84	186.39	0.00
BRTR	0.25	31.61	41.93	0.00	0.50	31.64	186.42	0.00
CPUP	0.25	41.61	35.99	0.00	0.25	41.61	36.34	0.00

The Station Statistics Display shows the current SOH metrics for each SOH category.

The values shown in the columns labeled for station (best channel) and channel (worst channel) are separately configurable.

Thresholds for good/marginal/bad color coding is only configurable for the worst channel case.

Selection of a station is synchronized with other displays.

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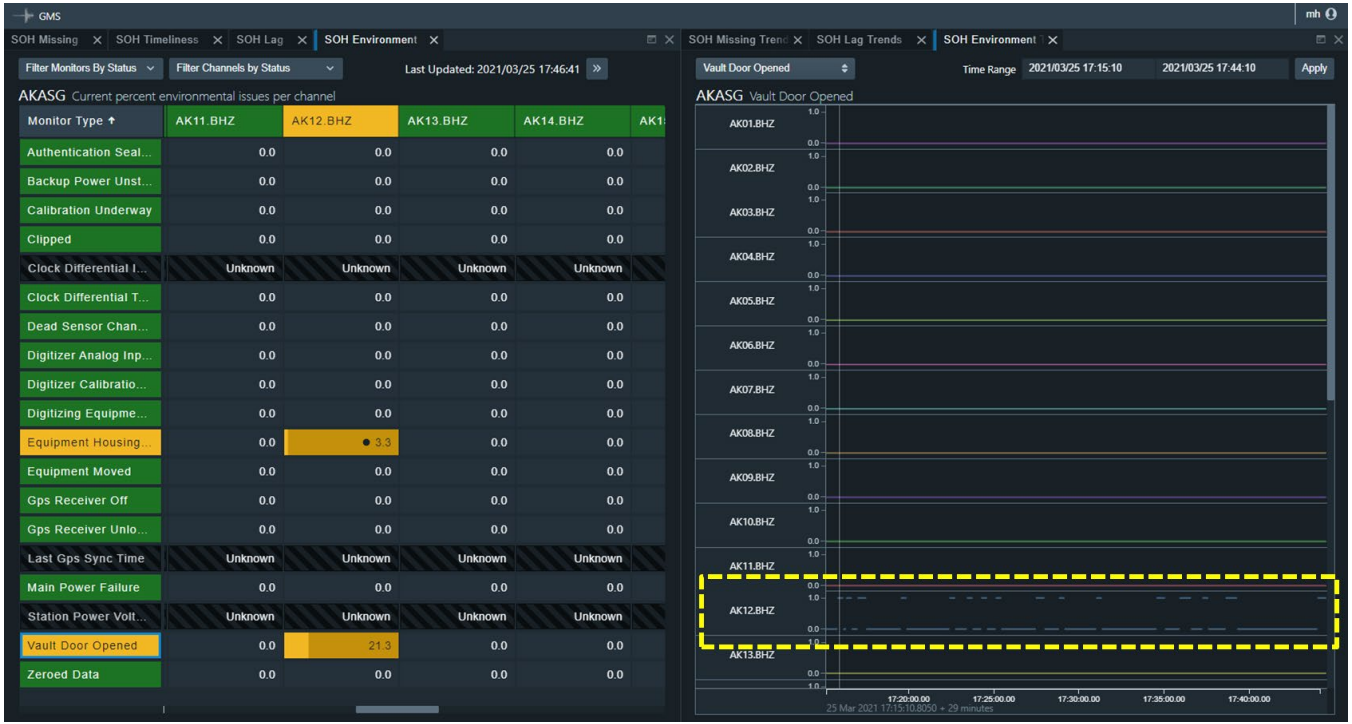
SOH Environment Drill-down Display



Each SOH metric category has drill-down displays showing the current status (left) and historic trend plots (right).

In this example, the AK12.BHZ channel was seen to have a high percentage of bad status bits for "Vault Door Opened" (left). The trend plot shows that this bit is switching randomly from low to high, likely indicating a faulty switch or circuit (right).

Metrics that have changed or have been quieted by the operator are indicated on the drill-down displays.

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SOH Missing Trends Drill-down Display

In this view of the SOH Missing Trends Display, the Average Missing data percentage is shown for each channel for the Time Range selected. The lower panel shows a trend plot for each channel, with colors matching the upper display.

The channels shown may be down-selected to reduce complexity.

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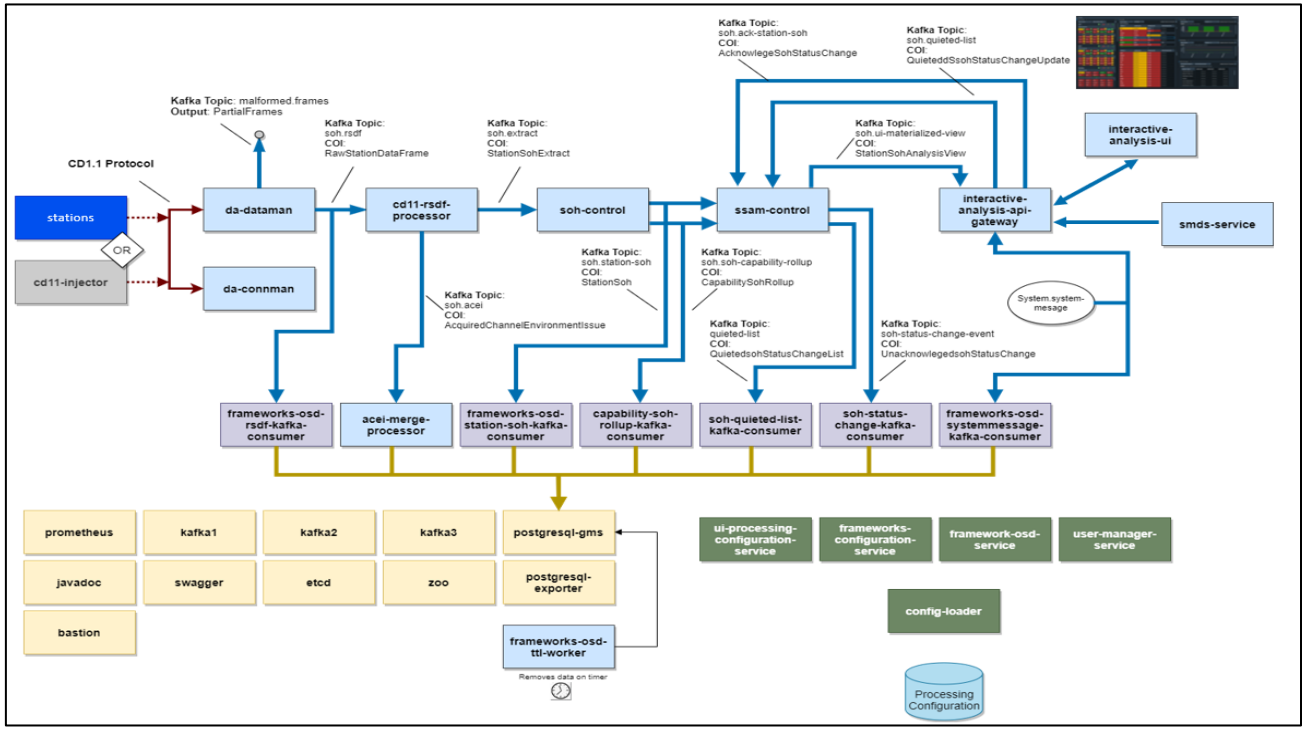
GMS Architecture



- 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.

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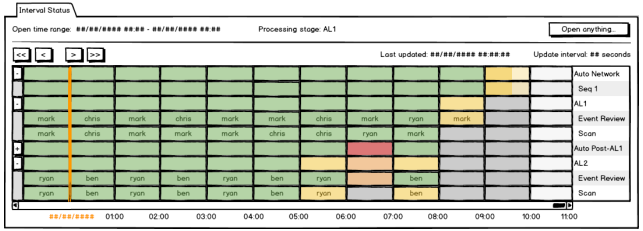
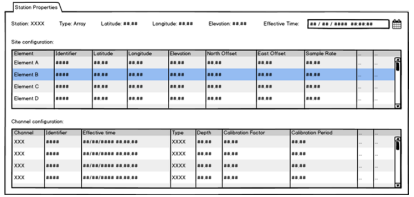
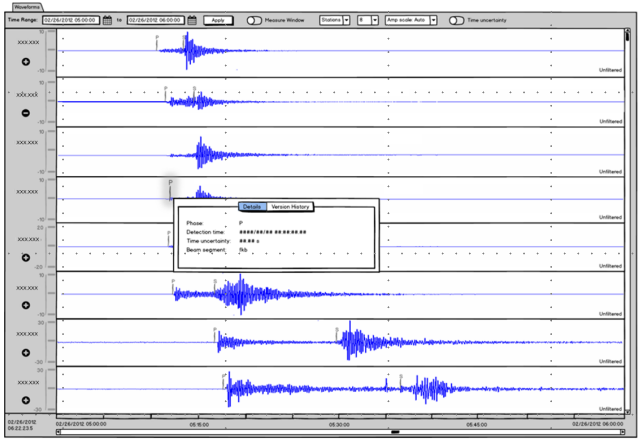
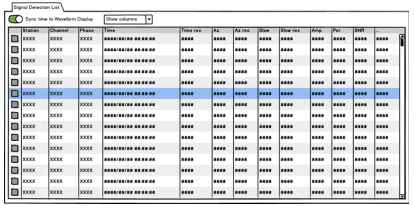
Future GMS Development









The GMS project is transitioning 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 format.

The next open source release is planned for late 2021

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