SAND2021-3981PE

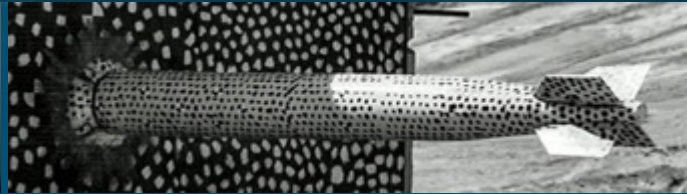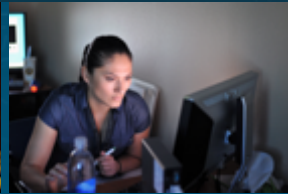# Geophysical Monitoring System (GMS) Global Associator (GA)
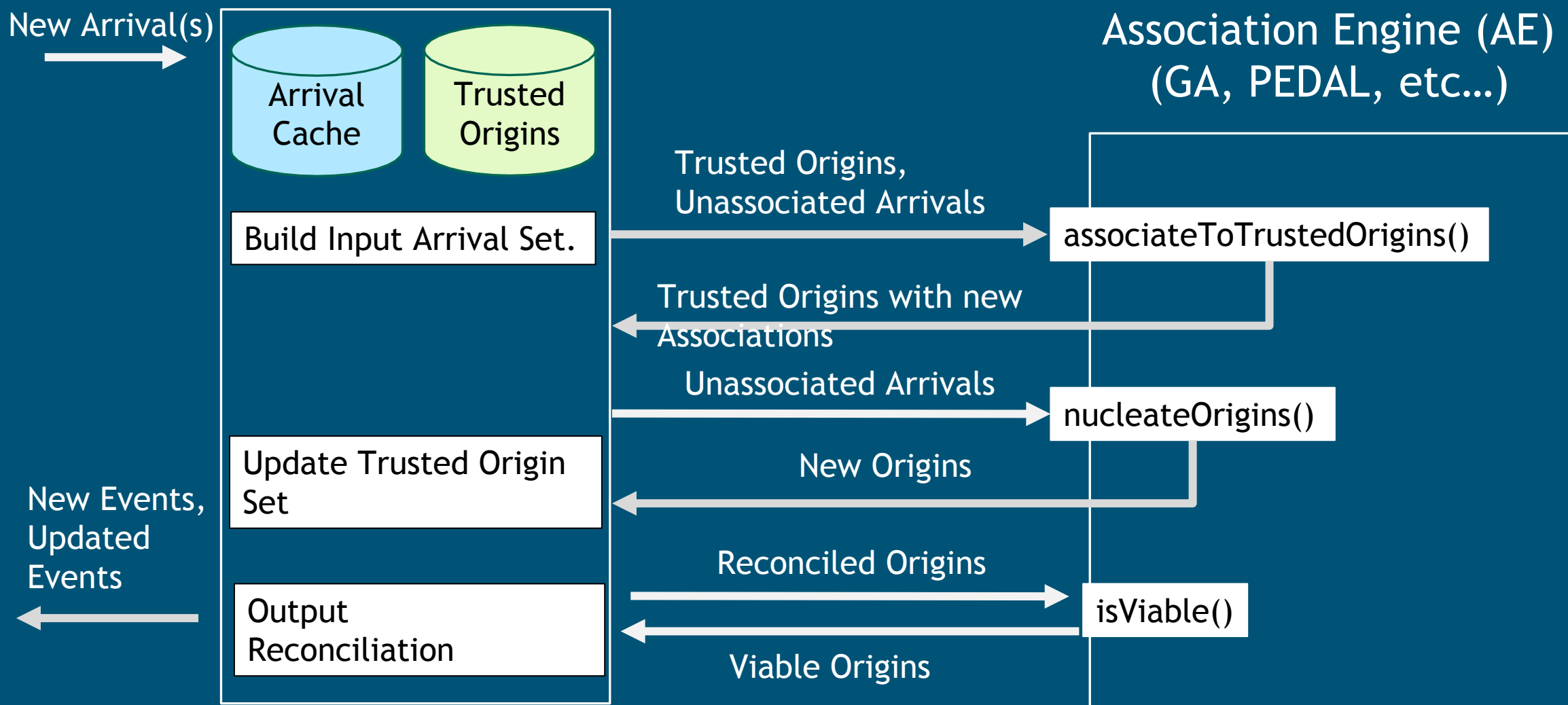
PRESENTED BY

Stephen Heck

April 6th 2021

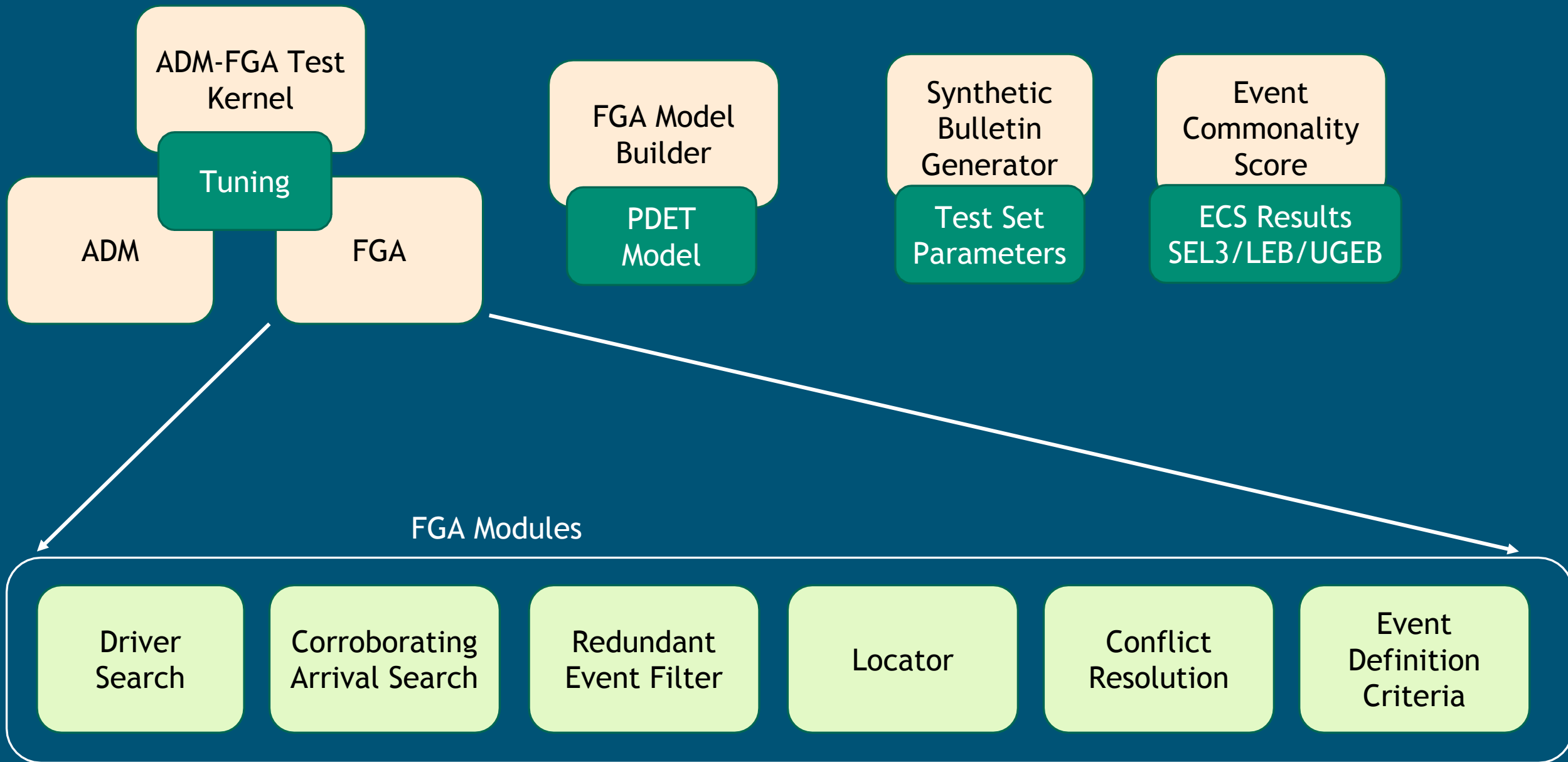TODO SAND #

Association Prototype Core Architecture

Associator Data Management (ADM)

New Arrival(s) →

Arrival Cache

Trusted Origins

Build Input Arrival Set.

Update Trusted Origin Set

New Events, Updated Events ←

Output Reconciliation

Association Engine (AE) (GA, PEDAL, etc…)

Trusted Origins, Unassociated Arrivals →

associateToTrustedOrigins()

← Trusted Origins with new Associations

Unassociated Arrivals →

nucleateOrigins()

← New Origins

Reconciled Origins →

isViable()

← Viable Origins

Prototyping Effort Java Software Libraries/Data Products

ADM-FGA Test Kernel

Tuning

ADM

FGA

FGA Model Builder

PDET Model

Synthetic Bulletin Generator

Test Set Parameters

Event Commonality Score

ECS Results SEL3/LEB/UGEB

FGA Modules

Driver Search

Corroborating Arrival Search

Redundant Event Filter

Locator

Conflict Resolution

Event Definition Criteria

Global Associator Prototyping Accomplishments

ADM

➢Implemented (July 2019)

GA implementation

➢Conflict Resolution (July 2019)

➢Station models using GeoTess (Aug 2019)

➢Grid Search (Aug 2019)

➢Chi-Squared Test (Aug 2019)

➢Location Module (July 2019)

➢*Added Probability of Detection to Station Models (Jan 2021)*

➢*FGA module result logging and Replay Association Engine (June 2020)*

Synthetic Test Generation

➢Implemented (Dec 2019)

➢*Station noise estimation (July 2020)*

➢*Event magnitude➔ Arrival SNR via Murphy-Barker (July 2020)*

ADM-FGA Testing

➢Perfect data (Nov 2019)

➢Off-grid origins + perfect arrivals (Nov 2019)

➢Off-grid origins + perturbed arrivals (Jan 2020)

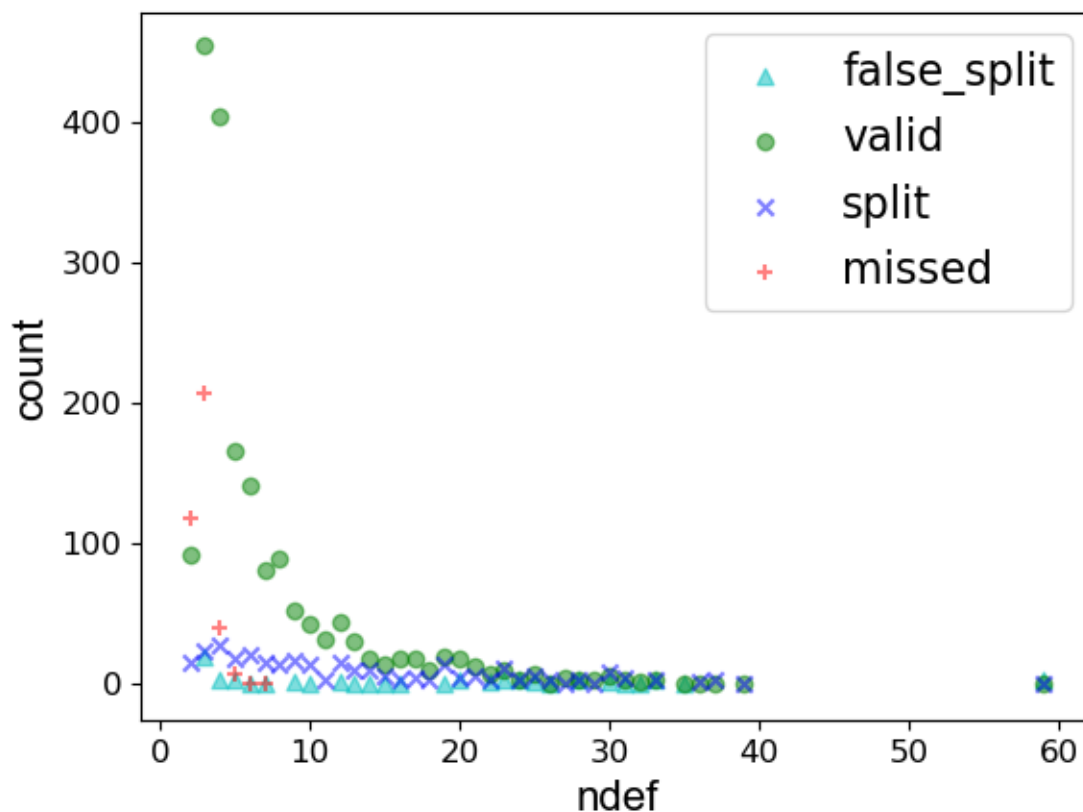➢*IMS Synthetic dataset testing (Oct 2020)*

➢*LEB FGA Testing (Jan 2021)*

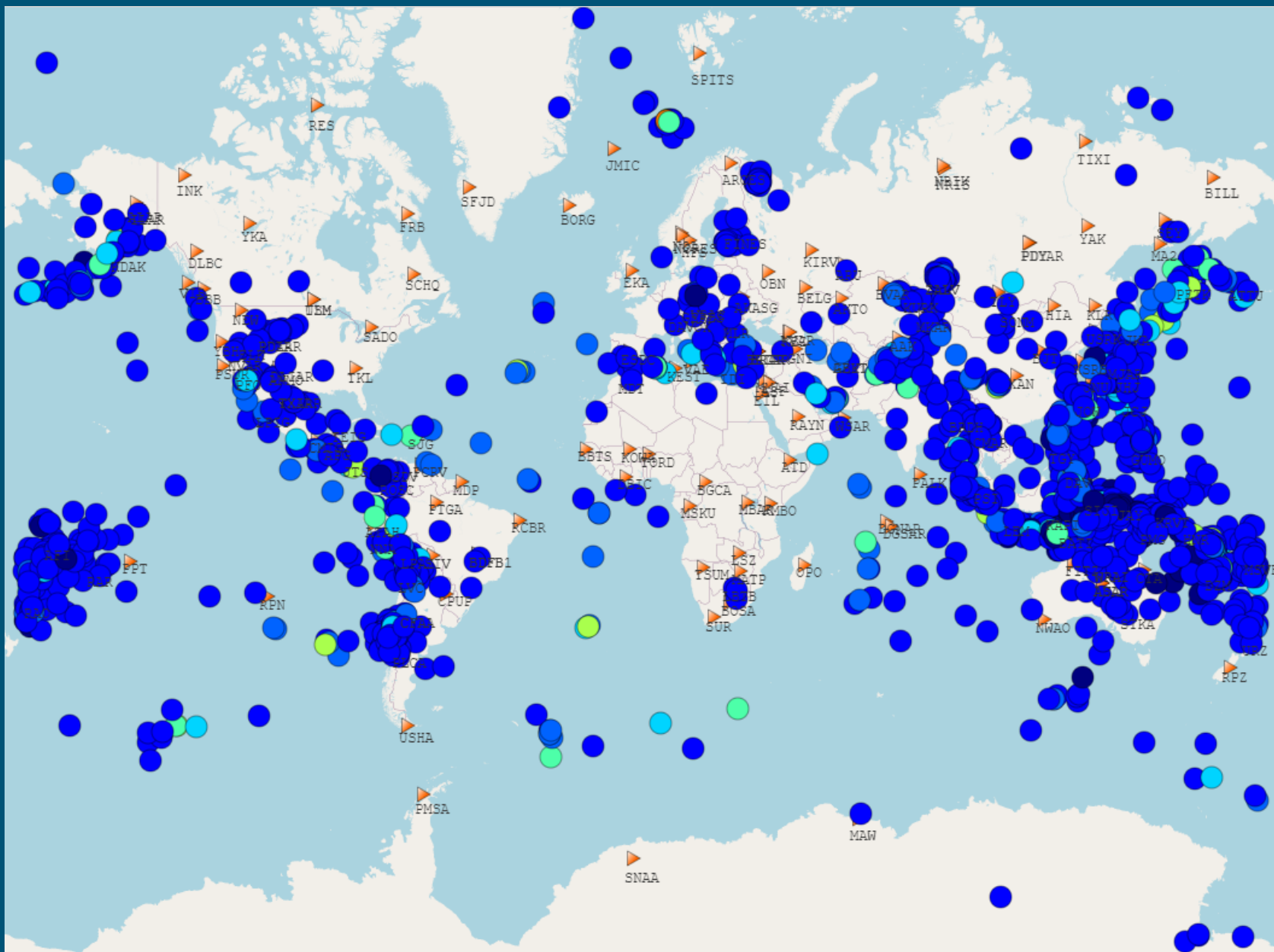# FGA Only vs SEL3 ECS Results (May 15, 2010 – May 29, 2010)

ECS Type	Num	ECS med	Loc med	FA med	MA med	CA med
VALID	1826	0.99	1	1	1	0.8
MISSED	376	0	0	0	0	0
FALSE	0	0	0	0	0	0
SPLIT	310	0.6	0.83	0	0	0
FALSE_SPLIT	66	0.14	0.01	1	0.14	0.15

Notes:
Missed: 176 of 376 have >= 50% Hydro/Infrasound Assocs

FGA Only vs SEL3 ECS Valid Locations
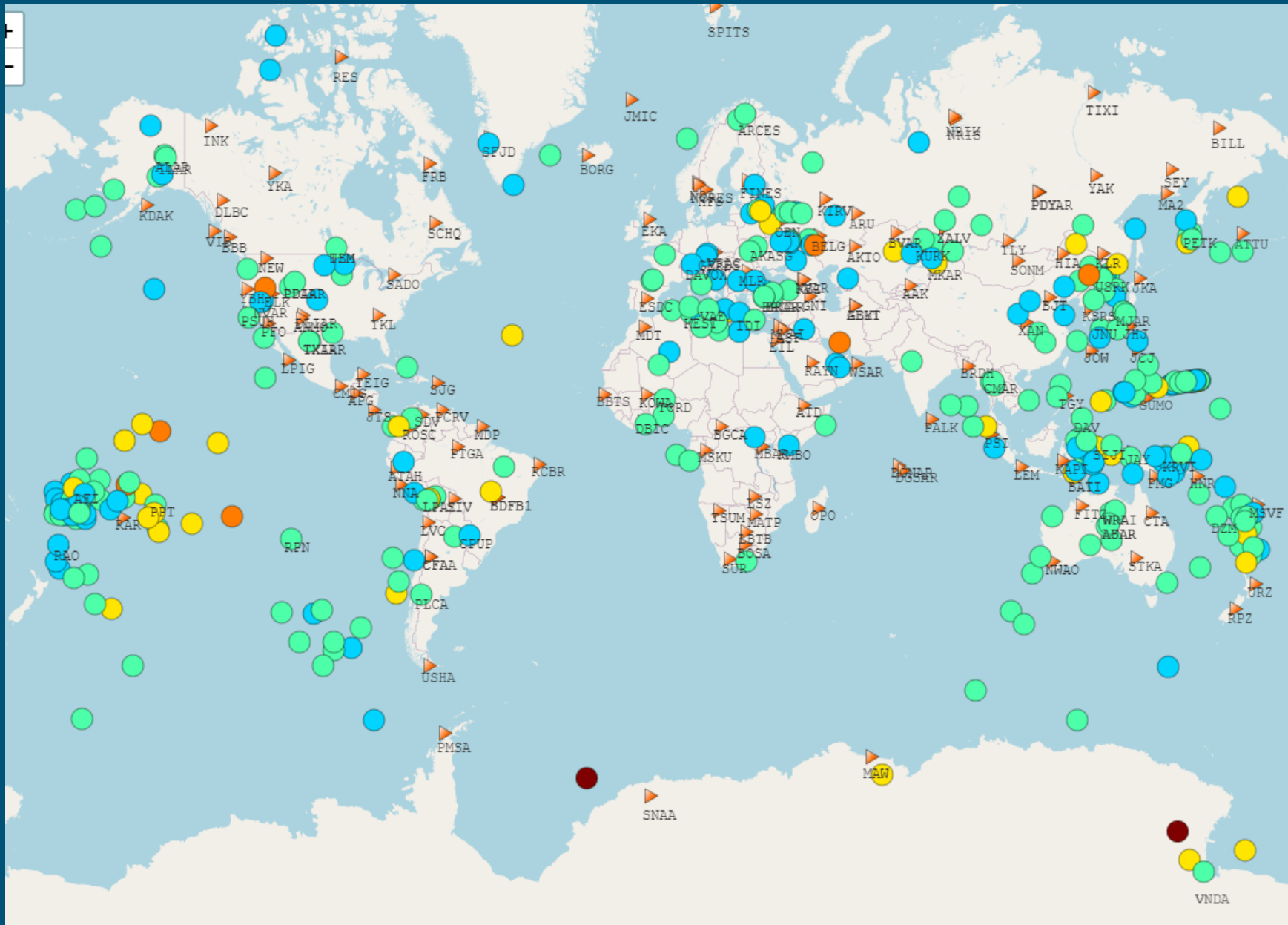
Global Associator Prototyping Current Work

SEL3 Testing and Tuning (Subject Domain Concerns)

➢ Match or beat the SEL3 Bulletin

➢ Streaming SEL3 detections through ADM-FGA

➢ Additional GA components
  ➢ Large event processing
  ➢ Regional phase grouping logic
  ➢ Predicted phase search

On the horizon (GMS Engineering Concerns)

➢ Computational performance testing

➢ Design using GMS Architecture/Technologies/Data Model

Extra Slides

GMS Global Associator Requirements

Specifications (SSD)

➢Section 3.2.6.1 Network Signal Association

➢Section 3.2.6.2 Late Network Signal Association

➢Section 3.2.6.3 Waveform Correlation

➢Section 3.2.6.4 Conflict Resolution

➢Section 3.2.6.5 Station Quality Metric

➢Section 3.2.6.6 Event Hypothesis Quality Metric

Use Cases

➢Section 2.6 System Builds Events using Signal Detections

User Interface Storyboards (UIS)

➢N/A

Current USNDC Implementation

➢ C code implementation

➢ Processing flows through a series of heuristic modules/steps

➢ Modules have been added over time

➢ GA philosophy: Build all possible event hypotheses and gradually filter down to the "best" events.

Global Associator Prototyping Motivation

- ➤ Data-driven Association with Association Data Management library (ADM)
  - ➤ Separate associator state management from the specifics of the association algorithm

- ➤ Build a working knowledge of the GA algorithm
  - ➤ Extensive testing on synthetic and real data

- ➤ Opportunity to review GA design/implementation from the GMS design perspective
  - ➤ Easy to maintain/extend implementation
  - ➤ Modern distributed processing frameworks

- ➤ Prototyping the association algorithm allows our team to iterate and adapt in a fashion that doesn't fit into the GMS development process.

- ➤ Give the GMS team an implementation that "bridges the gap" between requirements and the production system code
  - ➤ Develop new implementation in Java