Expansion of the Tsunami Buoy Array: Beginnings of a Global Network

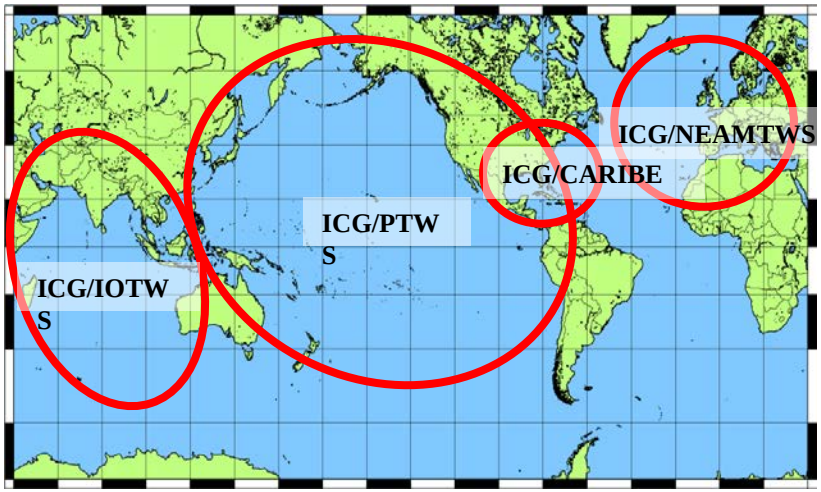
Robert Lawson
Senior Director, SAIC International Tsunami Buoy Program
21 November 2014

SAIC®
From Science to Solutions

26 December 2004 Mega Tsunami

The Aftermath of the Sumatra Tsunami

- Demonstrated global lack of adequate tsunami warning systems
- IOC establishes the ICG/IOTWS, ICG/NEAMSTWS, ICG/CARIBE EWS
- Increasing emphasis in the ICG/PTWS
- NOAA upgrades DART I systems to DART II
- begins deployment of 39 systems



- DART II system considered the “Gold Standard”
- International interest in DART Technology based systems increases
- SAIC develops STB system and is licensed by PMEL (2006-2007)

SAIC Tsunami Buoy (STB)

The SAIC Tsunami Buoy (STB) is an enhanced version of the NOAA Deep-ocean Assessment and Reporting of Tsunami (DART®) system.

- **Meets DART® operational and performance standards**
- **Dual direction and redundant communication**
- **Compatible with established DART® design**
- **Integrates easily into global tsunami assessment network**
- **Follows DART® test and evaluation procedures**
- **SAIC is licensed by NOAA**

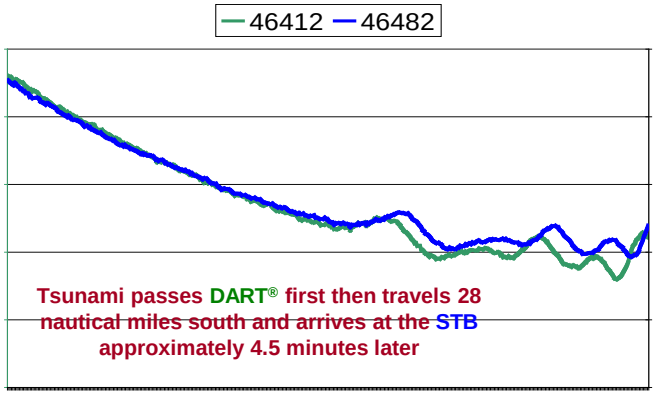
DART® tsunami technology

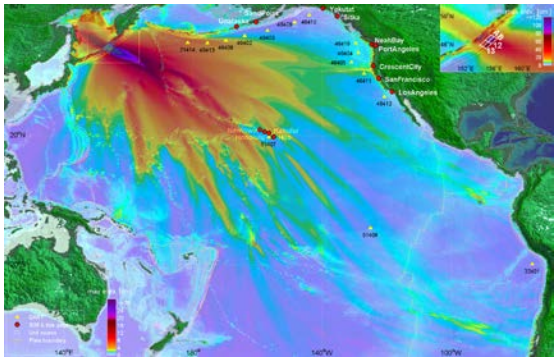
SAIC® From Science to Solutions

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC Tsunami Buoy Prototype
13 Months Testing At Sea

- **13 months of continuous at-sea operations and testing**
- **Side-by-side test with NOAA DART® system**
- **Detects 8.3 M earthquake in the Kuril Islands and micro-trans-Pacific tsunami on 15 November 2006**





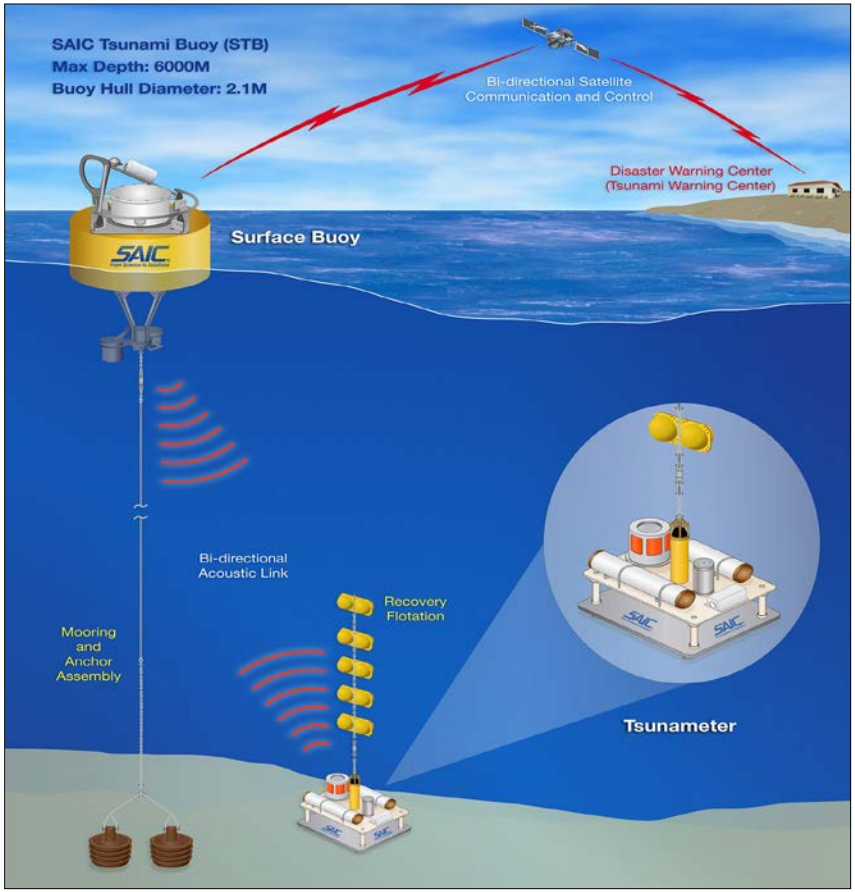
- **SAIC Tsunami Buoy (STB) meets or exceeds all DART® performance standards**
  - **Data transmission 97 percent**
  - **Back-channel commands**
  - **Outstanding data correlation with DART 46412**
  - **Certified and licensed by NOAA**

Energy | Environment | National Security | Health | Critical Infrastructure

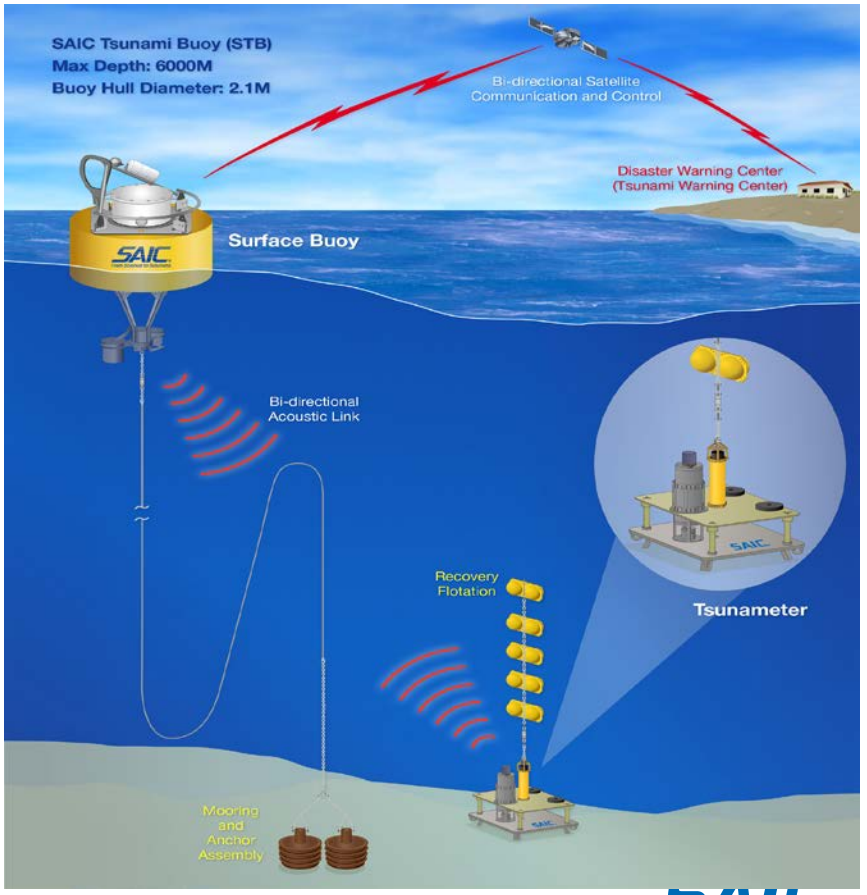
SAIC® From Science to Solutions

SAIC Tsunami Buoy (STB) System

Low Frequency Version



Mid Frequency Version



Energy | Environment | National Security | Health | Critical Infrastructure

SAIC® From Science to Solutions

STB and NOAA DART® Specifications

Mandatory Characteristic	Specification
Measurement sensitivity	Less than 1 millimeter in 6,000 meters
Sampling interval, internal record	15 seconds
Sampling interval, event reports	15 and 60 seconds
Sampling interval, tidal reports	15 minutes
Two-way end-to-end communications (two channels)	On demand, tsunami warning center trigger
Tsunami data report trigger	Automatically by tsunami detection algorithm
Data flow, BPR to TWC	Less than three minutes after triggered event
Desired Characteristic	**Specification**
Reliability and data return ratio	Greater than 80 percent (STB 98 percent)
Maximum/minimum deployment depth	6,000 meters/1,500 meters
Maximum deployment conditions	Sea State 4
Theoretical battery life, buoy	Greater than two years
Theoretical battery life, tsunameter	Greater than four years
Maximum status report interval	Less than 6 hours

SAIC Tsunami Buoy (STB) meets or exceeds DART specifications

BPR = bottom pressure recorder

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC From Science to Solutions

SAIC Tsunami Buoy Production Facility – San Diego

- 2600 square meter facility
- Assembly and integration
- Quality assurance area
- Shipping and receiving
- R&D machine shop
- Electronics and mechanical engineering lab
- 3-D modeling
- Production readiness
- ISO-9001:2008 Registered Facility

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC® From Science to Solutions

STB Production

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC®
From Science to Solutions

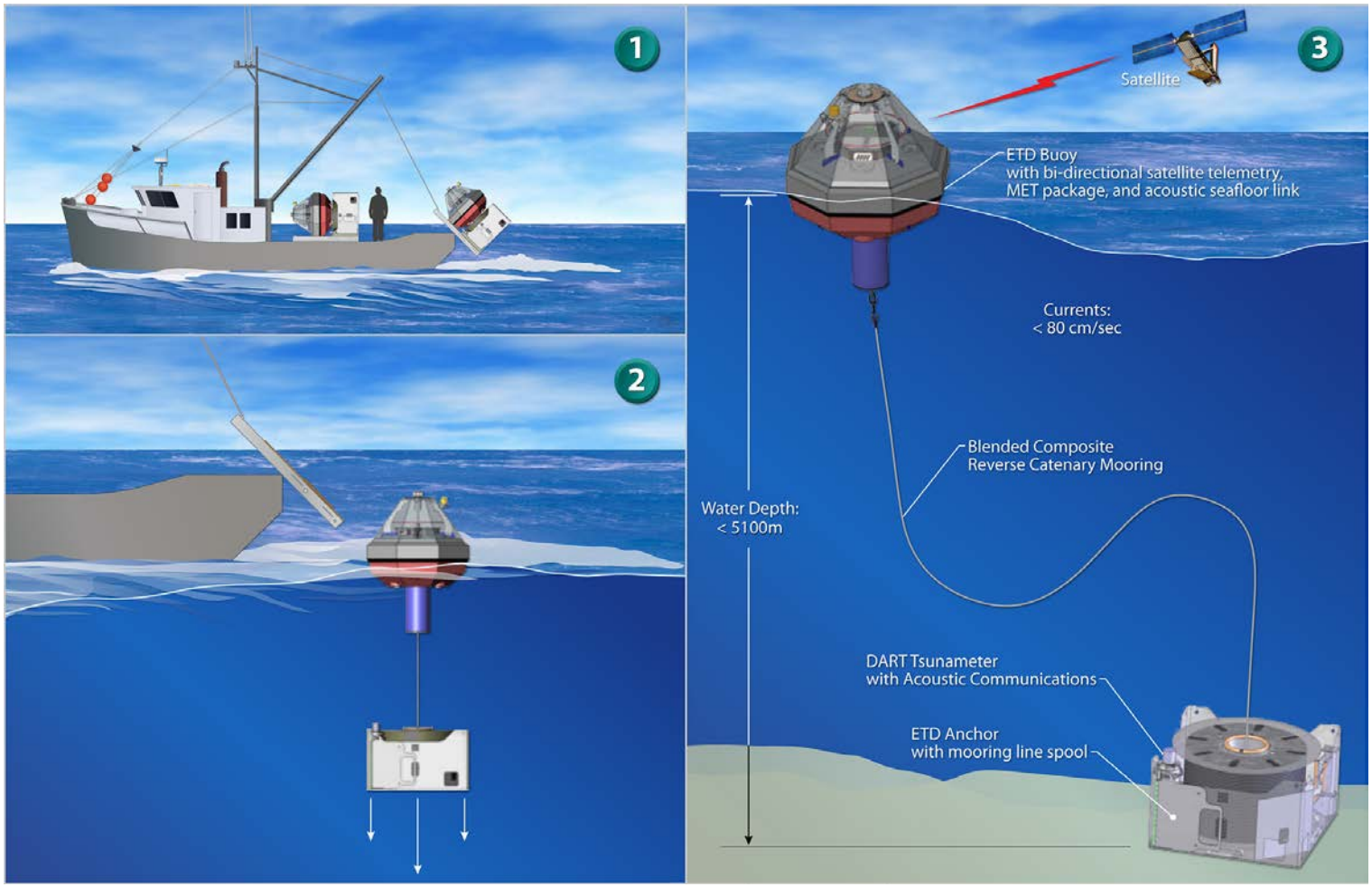
Deployment of STB

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC
From Science to Solutions

Easy-to-Deploy (ETD) DART Configuration

- Developed by Pacific Marine Environmental Lab
- Transitioned from Research to Operations in 2009



Energy | Environment | National Security | Health | Critical Infrastructure

SAIC
From Science to Solutions

Easy-to-Deploy (ETD) DART Characteristics

- Deploy from small fast ship, tug, or fishing boat
- Rapid deployment
- Gravity induced launch
- Little deck equipment necessary
- Safer deck operations in heavier seas
- Sensitive to oceanographic conditions (currents and depth)
- Surface buoy recoverable
- Anchor / BPR are not recovered

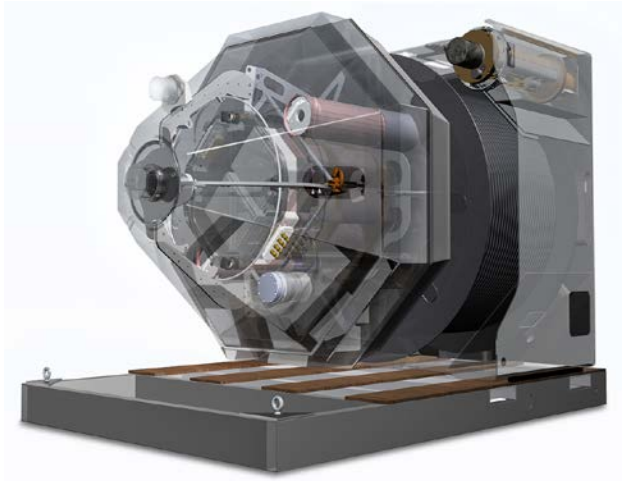
Energy | Environment | National Security | Health | Critical Infrastructure

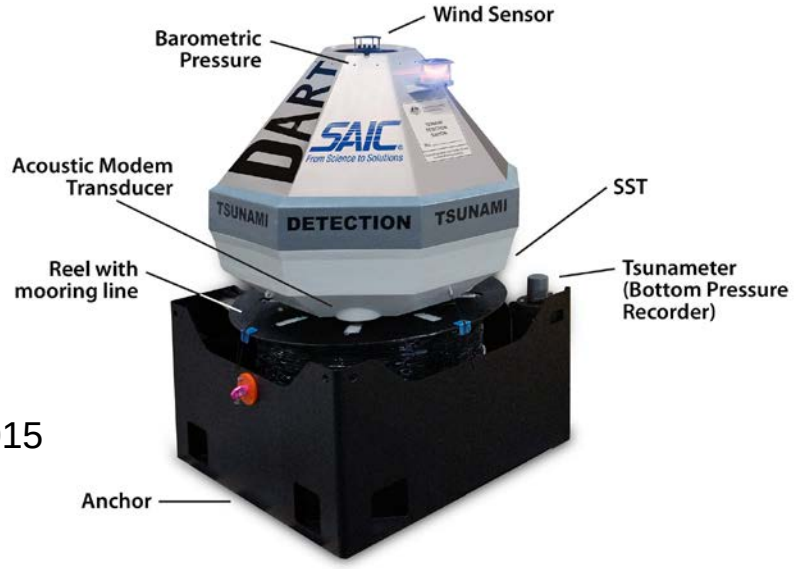
SAIC
From Science to Solutions

Easy-to-Deploy (ETD) DART

License Agreement signed between Pacific Marine Environmental Laboratory (PMEL) and SAIC in 2009

- Australia deploys NOAA ETD DART in Tasman Sea in 2009
- SAIC produces first commercial ETD DART for international and domestic requirements 2010
- ETD DART BPR deployed at North Pole in June 2010
- ETD DART #1 deployed in the Coral Sea in August 2010
- ETD DART #2 deployed in the Tasman Sea in April 2011
- ETD DART #3 deployed south of Bali on 12 February 2012
- ETD DART #4 deployed in Kuril Islands in SEP 2012
- ETD DART #’s 5 and 6 deployed in Coral Sea in March 2014
- ETD DART #7 to be deployed in Tasman Sea in February 2015
- ETD DART #8 in production





ETD DART® Specifications

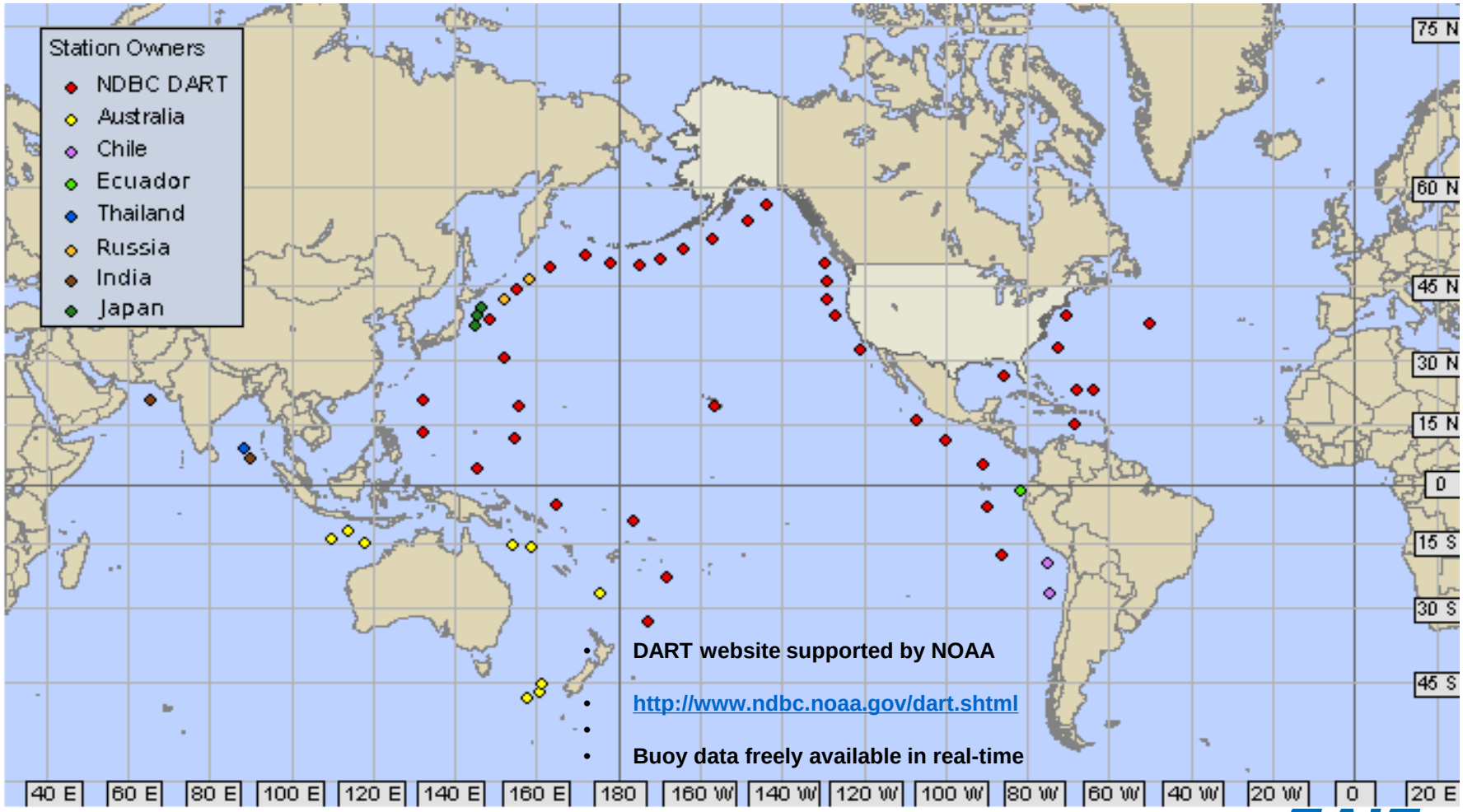
Mandatory Characteristic	Specification
Measurement sensitivity	1 millimeter in 5,000 meters
Sampling interval, internal record	15 seconds
Sampling interval, event reports	15 and 60 seconds
Sampling interval, tidal reports	15 minutes
Two-way end-to-end communications (two channels)	On demand, tsunami warning center trigger
Tsunami data report trigger	Automatically by tsunami detection algorithm
Data flow, BPR to TWC	Less than three minutes after triggered event
Desired Characteristic	**Specification**
Reliability and data return ratio	Greater than 80 percent
Maximum/minimum deployment depth	5,100 meters/1,500 meters
Maximum surface/subsurface currents	Less than 1.5 knots (80 cm/sec)
Deployment conditions	Sea State 5
Nominal system weight	2.5 tons
Deployment vessel	Greater than 60 feet LOA
Theoretical battery life, buoy	Greater than two years
Theoretical battery life, tsunameter	Greater than four years
Maximum status report interval	Less than 6 hours
Reconditioning cycle, buoy	Greater than two years; rotation
Maintenance cycle, BPR/Anchor subsystem	Greater than 4 years, total replacement

BPR = bottom pressure recorder
TWC = Tsunami Warning Center

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC® From Science to Solutions

Global Sharing of Tsunami Buoy Data



- **DART website supported by NOAA**
- **http://www.ndbc.noaa.gov/dart.shtml**
- **Buoy data freely available in real-time**

SAIC
From Science to Solutions

SAIC International Tsunami Buoy Program Highlights

Tsunami Buoy Production

- Meets DART® operational and performance standards
- Follows DART® test and evaluation procedures
- SAIC is licensed by NOAA

DART® tsunami technology

30 Systems Delivered as of 1 November 2014

7 Systems in Production

Customers include:

- Australia
- Chile
- China
- India
- Japan
- Russia
- Thailand
- NOAA

SAIC® From Science to Solutions

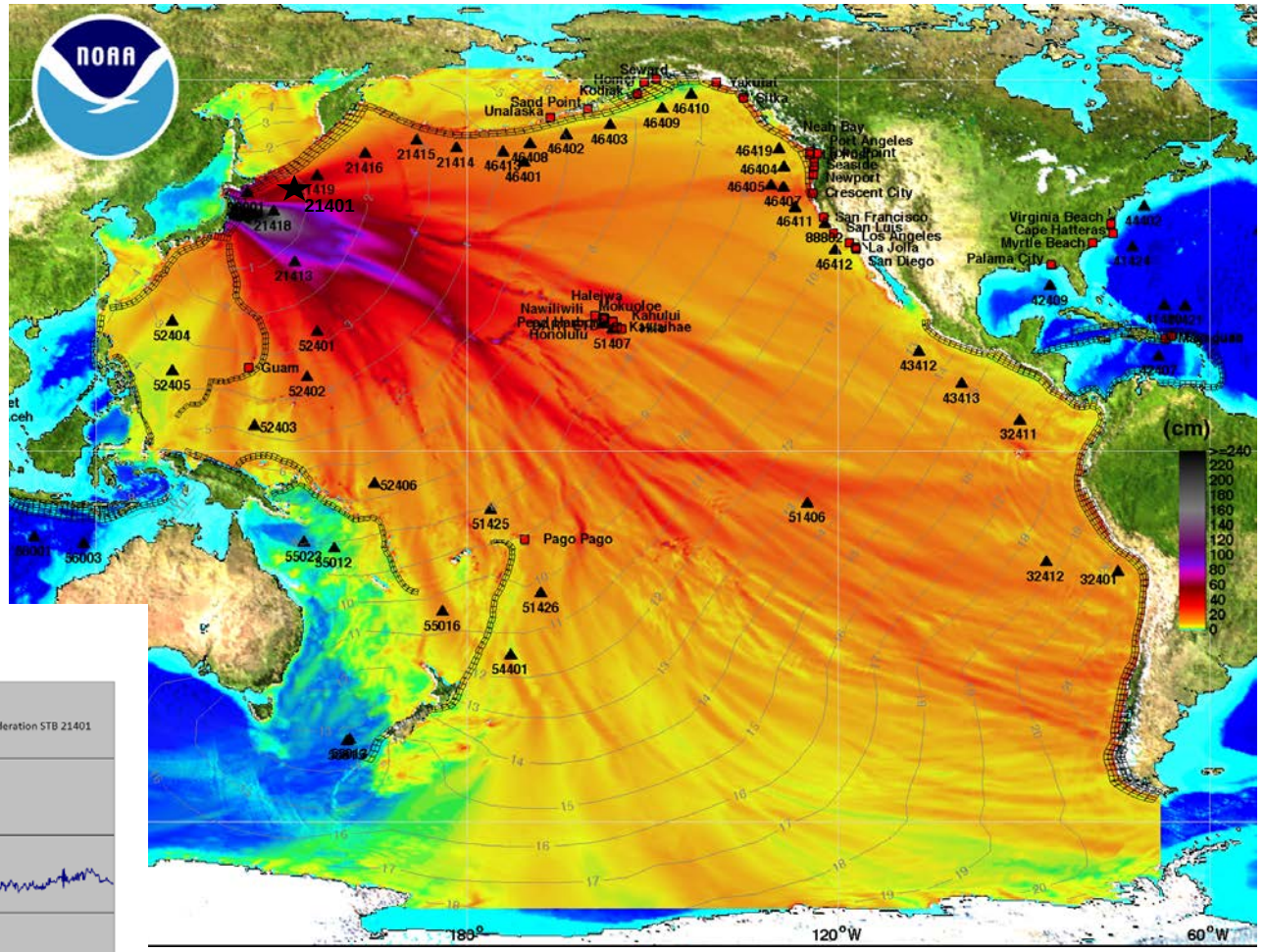
Honshu Tsunami, 11 March 2011

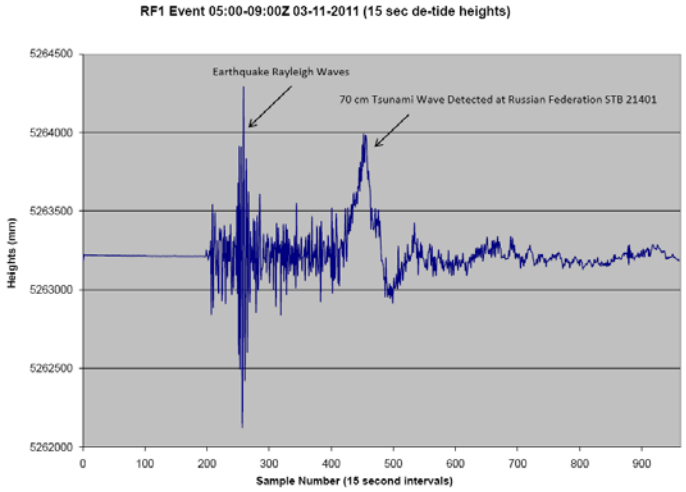
- Generated by a Magnitude 9.0 earthquake at 05:46 UTC, 130 km (80 miles) E of Sendai, Honshu, Japan

- First wave arrived at NOAA DART® Buoy 21418 in approximately 25 min

Arrived at Russian Federation STB Buoy 21401 in approximately 56 minutes (800 km)

STB data used with DART® data to provide accurate forecast results





onment | National Security | Health | Critical Infrastructure

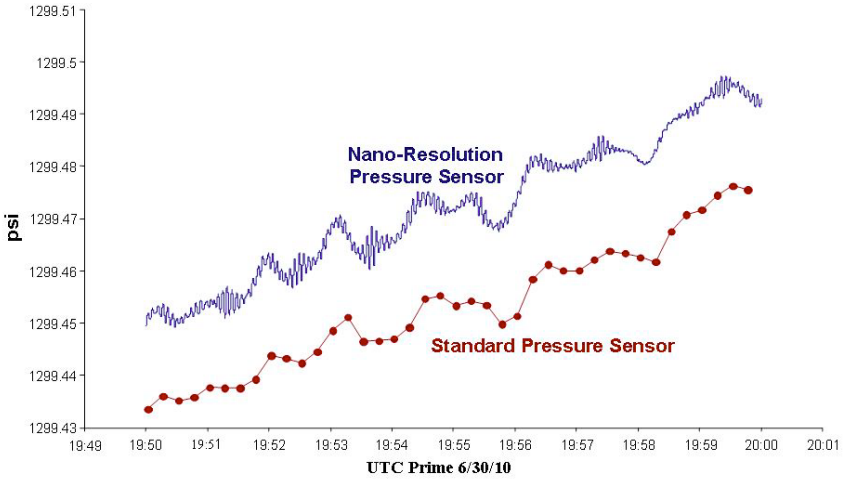
SAIC
From Science to Solutions

Fourth Generation – Near Field Capable Tsunami Assessment Buoy in Development

NOAA PMEL is developing a Fourth Generation Tsunami Buoy System - DART 4G

Advancements in sensors, software and power management hold promise that detection and measurement of near-field tsunamis with unprecedented resolution is now possible.

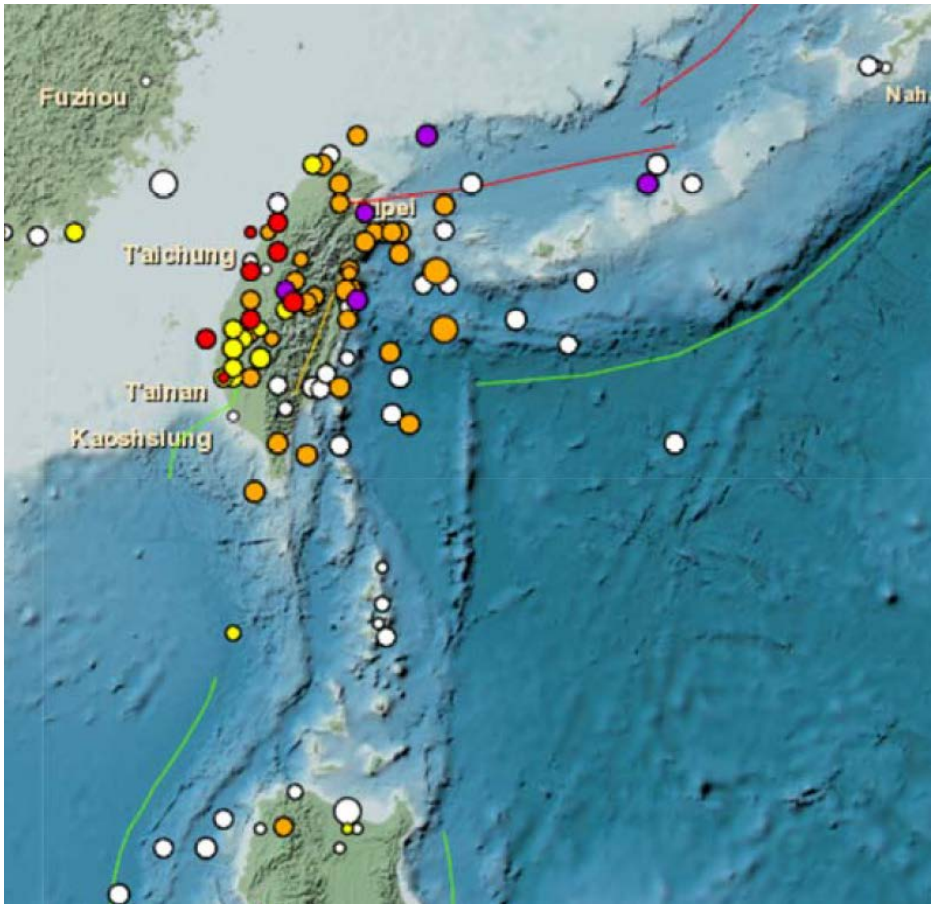
- New pressure sensor and software;
- Tsunami measured closer to the earthquake source
- Higher resolution tsunami height data transmitted while the earthquake is rupturing;
- Allows the separation of the tsunami signal from the earthquake “noise.”



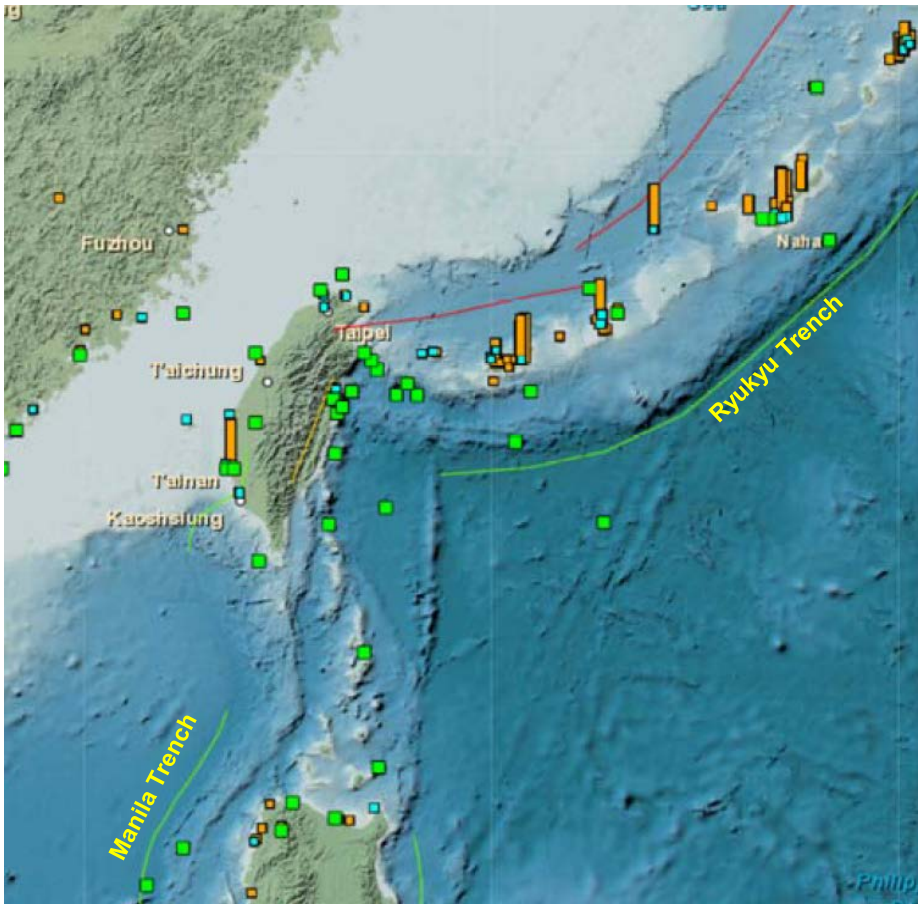
Transition of DART 4G capability to SAIC STB and ETD DART Systems to begin in October 2014

SAIC
From Science to Solutions

Historical Tsunamis and Major Earthquakes in the Region



Historical Major Earthquakes – From NOAA NGDC



Historical Major Tsunamis – From NOAA NGDC

SAIC
From Science to Solutions

Xie, Xie - Thank you!

Robert Lawson | SAIC
Senior Director International Tsunami Buoy Program
858.826.1166 office | 619.507.9382 mobile
lawsonra@saic.com | www.saic.com

Energy | Environment | National Security | Health | Critical Infrastructure

SAIC® From Science to Solutions