

## DOCKETED

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<b>Filer:</b>	Gina Fontanilla
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# GPS Excavation Enroachment Notification System (GPS EENS)

Project: PIR-15-015

**Natural Gas Infrastructure Safety and Integrity Workshop**

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Khalid Farrag, Ph.D., P.E.

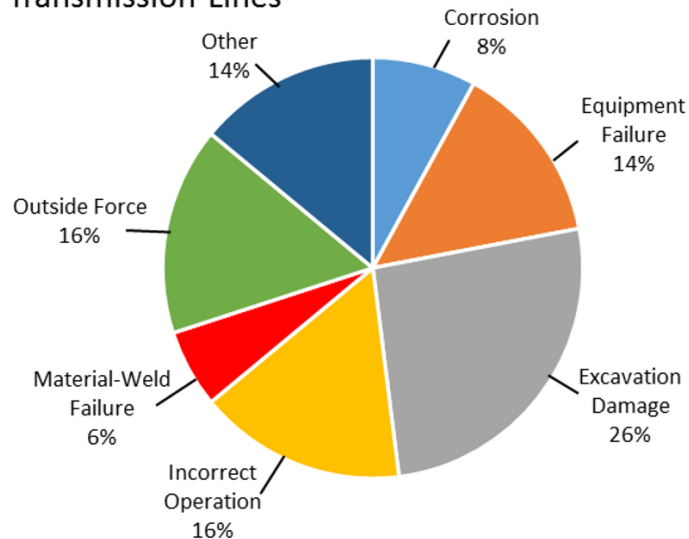
Robert Marros, PI

Gas Technology Institute

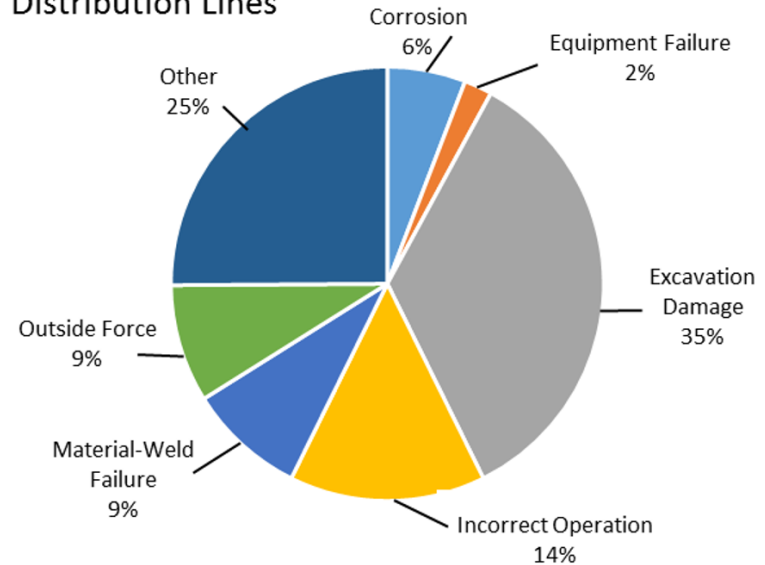


## GPS Excavation Enroachment Notification System (GPS EENS)

Transmission Lines



Distribution Lines



- Excavation damage is the most leading cause of pipeline failure incidents

Source: PHMSA, National Pipeline Performance Measures, [2005-2016]  
<https://phmsa.dot.gov/pipeline/library/data-stats/performance-measures>



## GPS Excavation Enroachment Notification System (GPS EENS)

# Background

- There is no current system that provides situational awareness of the excavator location, operating status, asset maps, related 811 Calls, or Right of Way (ROW) boundaries in real-time to operating utilities for effective monitoring and decision making.
- This project will provide utility operators with accurate GPS locations and operational status of excavating equipment in relation to their facilities in real-time. GPS, in conjunction with communications and other sensors, will be installed on excavators to provide real-time location and operational status.



## GPS Excavation Enroachment Notification System (GPS EENS)

# Project Objectives

- Deploy multiple-sensor units on excavation equipment within the utility service territory as well as the system architecture to support it. Both traditional excavation equipment and agricultural equipment will be included.
- Configure and deploy an operations dashboard showing excavator location, operational state, and alerts in real time.
- Utilize the system architecture to enhance emergency response situational awareness by providing a mobile platform for accurate incident location, targeted alerts and communications, and near real-time access to GIS asset maps.



## GPS Excavation Enroachment Notification System (GPS EENS)

### Technical Advisory Committee (TAC) Members:

	SME	Company/Affiliation
1	Francois Rongere	Pacific Gas & Electric (PG&E)
2	Aaron Rezendez	Pacific Gas & Electric (PG&E)
3	David Feliciano	Pacific Gas & Electric (PG&E)
4	Edward Newton	Southern California Gas Company (SoCal)
5	Rexford Cullen	Southern California Gas Company (SoCal)
6	James Merritt	U.S. DOT, PHMSA
7	Maureen Droessler	Operations Technology Development (OTD)
8	Thomas Young	CA CGA, SeeScan Inc.
9	Robert Smith	DigAlert , Southern CA

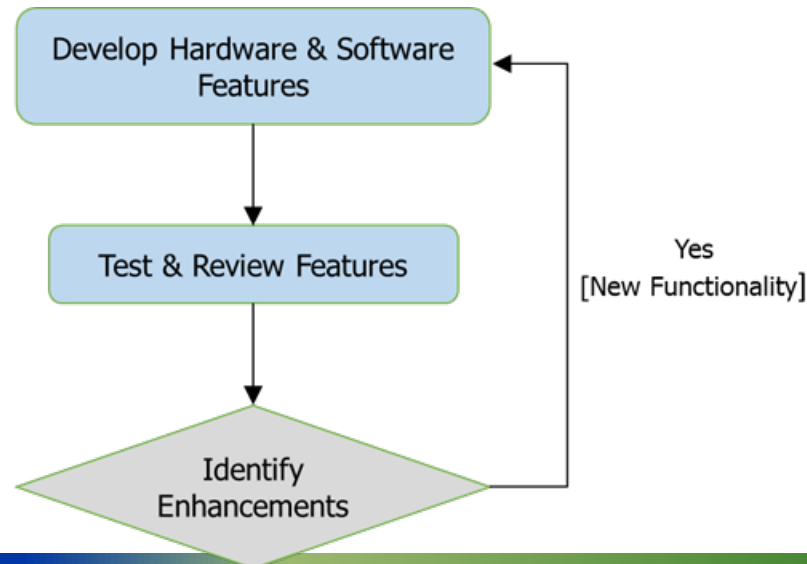


## GPS Excavation Enroachment Notification System (GPS EENS)

# Excavator Hardware Device

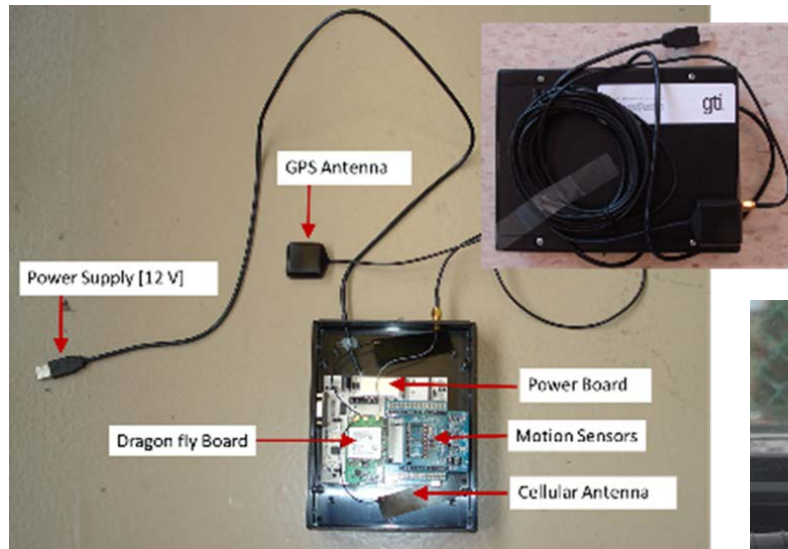
Utilize an Agile Process Management in the development of the hardware and software of the GPS-EEN System.

The process is an incremental method of managing the design of the system incorporating stakeholders feedback in staged development.



## GPS Excavation Enroachment Notification System (GPS EENS)

# Excavator Hardware Device



Prototype 2



Prototype 1



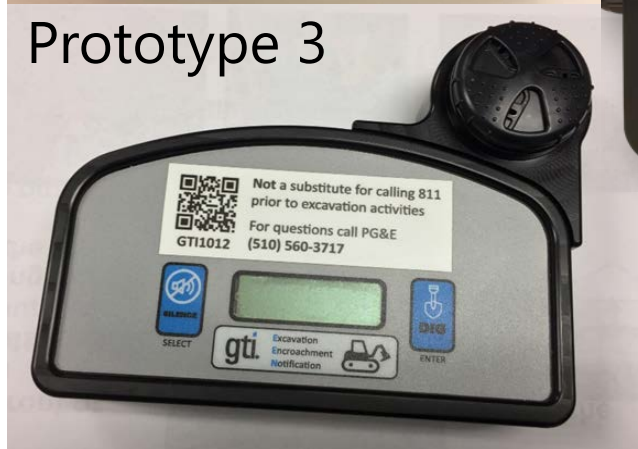


## GPS Excavation Enroachment Notification System (GPS EENS)

# Excavator Hardware Device



Prototype 3



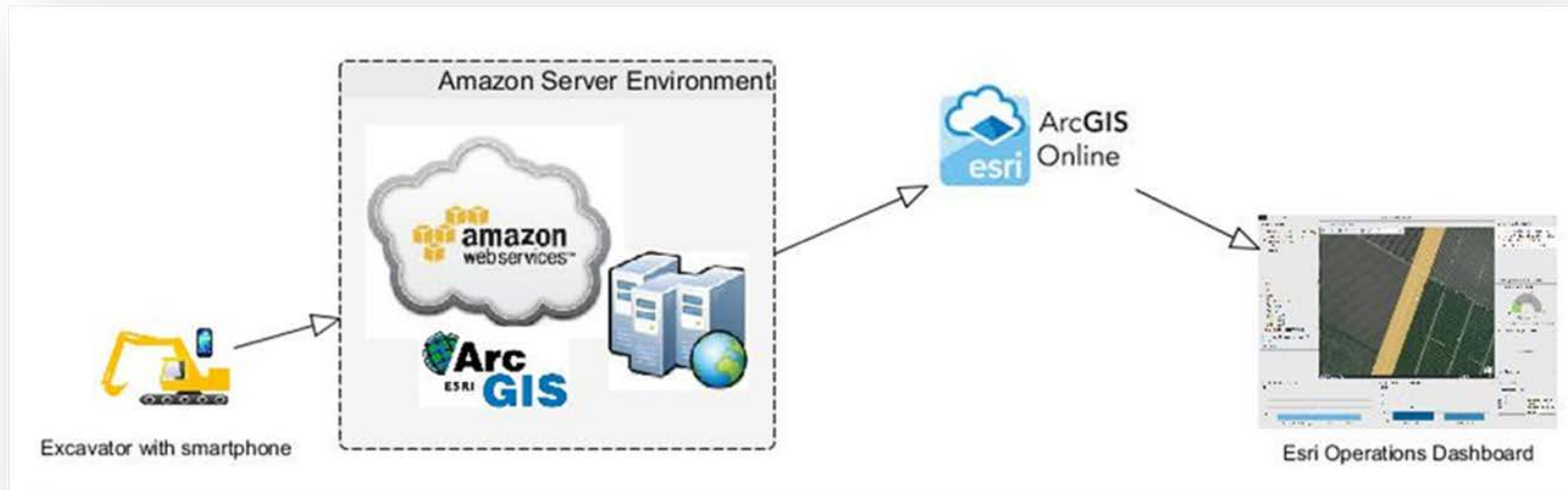
Prototype 4



## GPS Excavation Enroachment Notification System (GPS EENS)

# System Communication Protocol

- Take advantage of available technologies
- Create a cost-effective platform
- Size of data is a key system requirement
- Get information, provide awareness...





## GPS Excavation Enroachment Notification System (GPS EENS)

# System Communication Protocol

Device is installed in the excavator's cabin

Sensors in the device monitor:

- GPS location, speed
- Motion sensors to characterize equipment activities.





## GPS Excavation Enroachment Notification System (GPS EENS)

# System Communication Protocol



### Absolute Orientation

Integrates accelerometer, gyroscope and magnetometer



### Accelerometer

Detects linear motion and gravitational forces



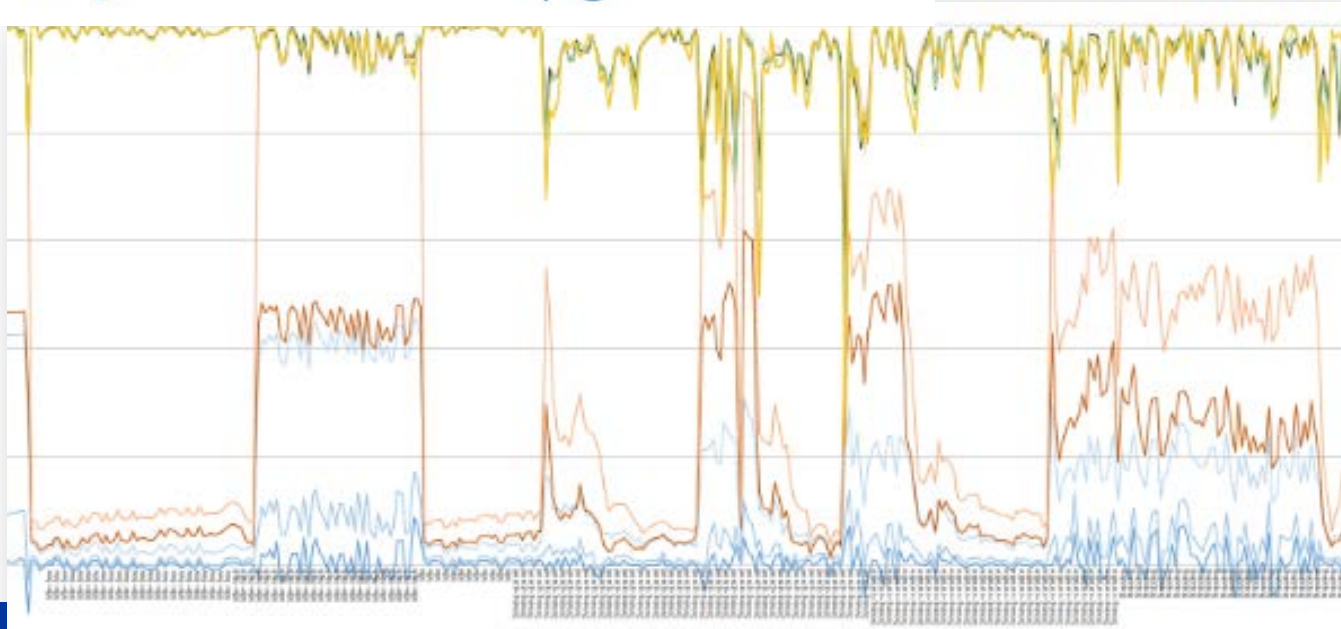
### Gyroscope

Measures the rate of rotation in space (roll, pitch, yaw)



### Magnetometer

Measures the terrestrial earth's magnetic fields





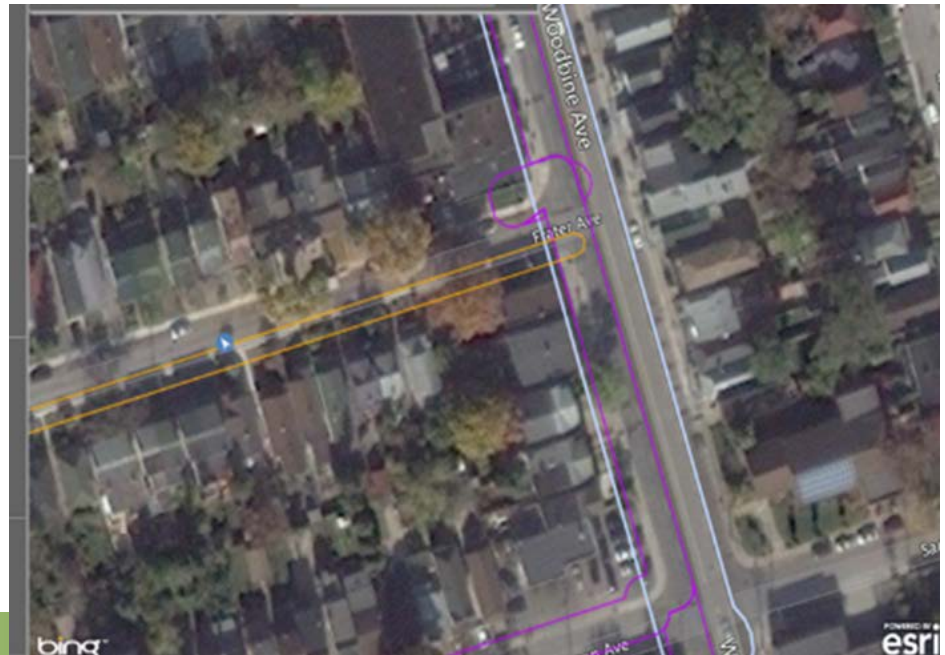


## GPS Excavation Enroachment Notification System (GPS EENS)

# System Communication Protocol

Signal is analyzed and triggers alarm if sensors in the device identify:

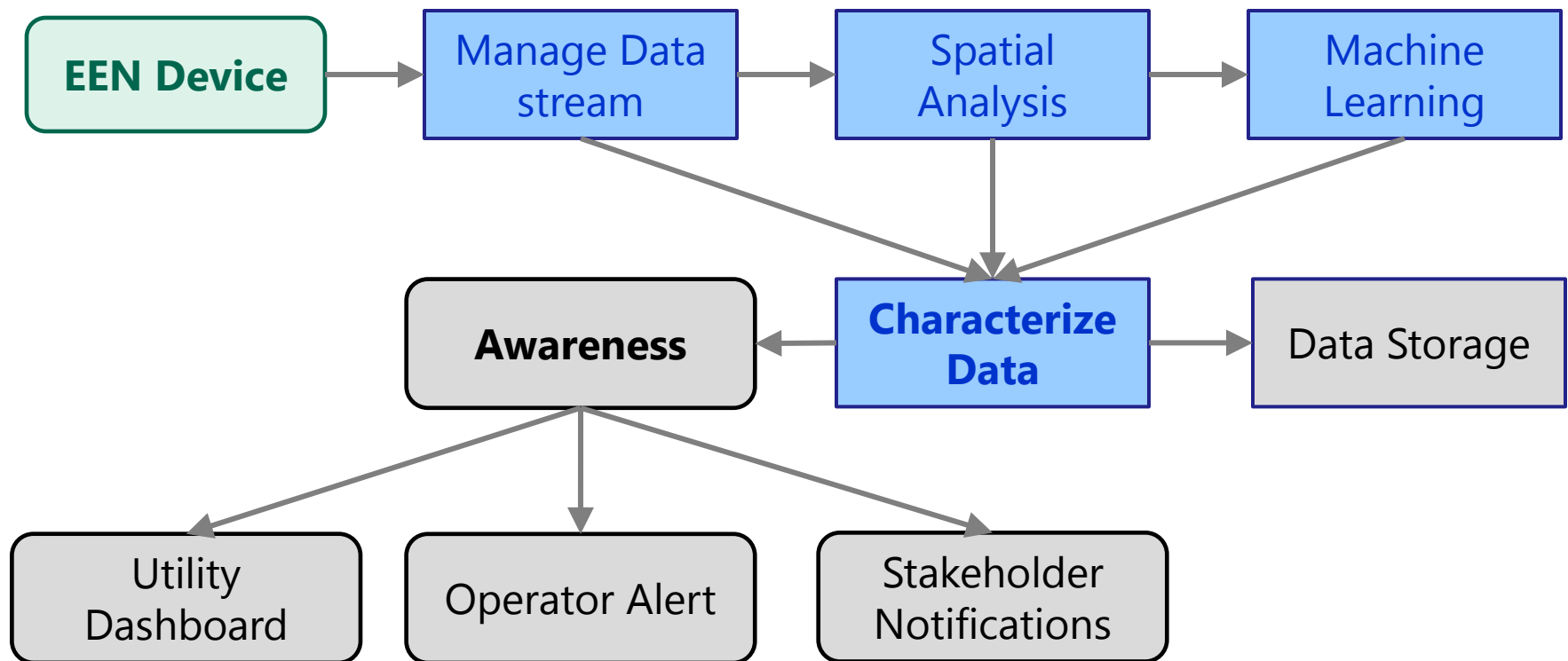
- Excavator inside utility-set 'Geo-fence' around pipeline,
- Speed less than 4 mph,
- Excavator motion and activities.





## GPS Excavation Enroachment Notification System (GPS EENS)

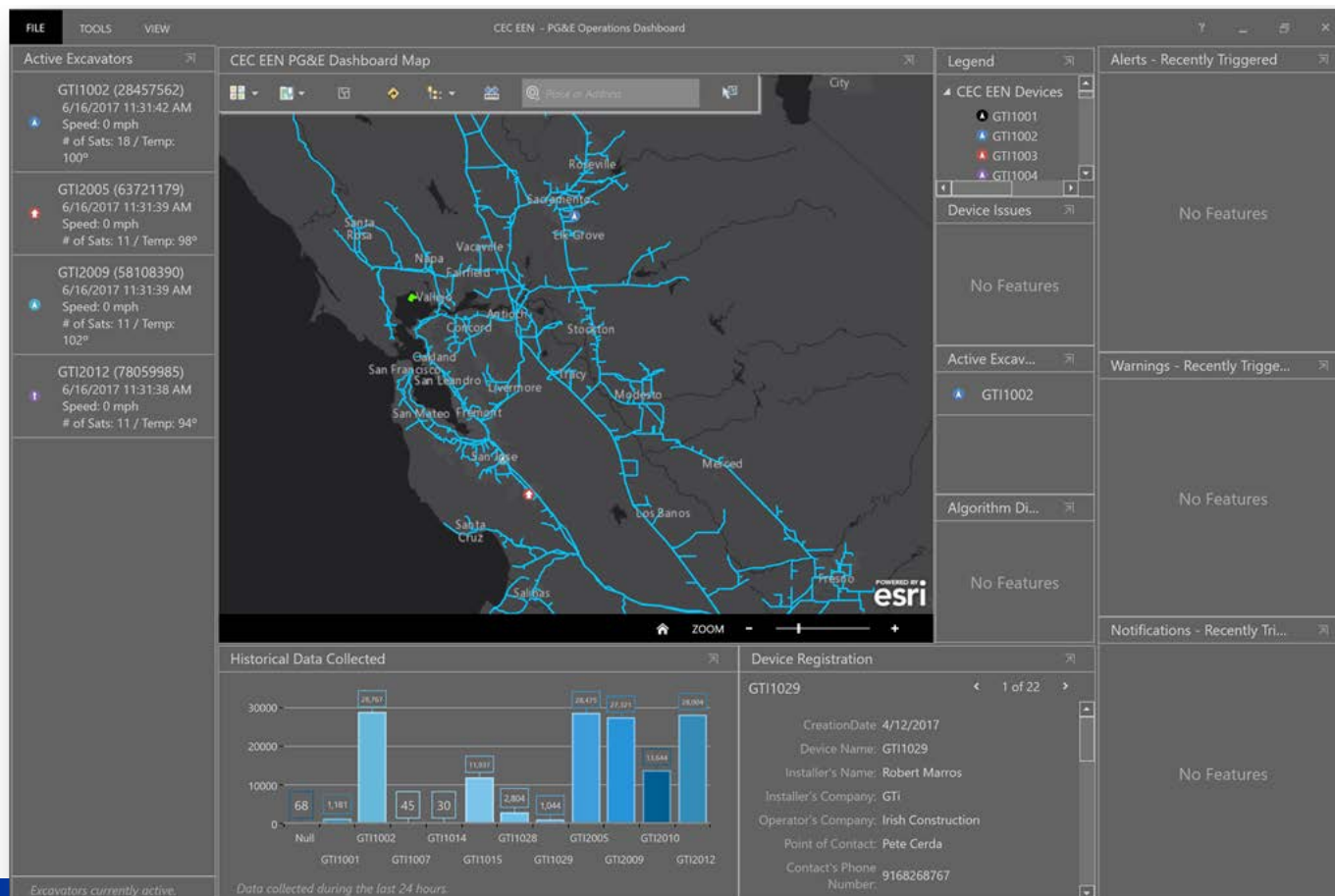
### Situation Awareness





## GPS Excavation Enroachment Notification System (GPS EENS)

# Situation Awareness, Dash Board





## GPS Excavation Enroachment Notification System (GPS EENS)

# System Deployment



GTI Test Site







# System Deployment

The screenshot displays the Inteligencia Mayor OpenStreetMap dashboard. The main map shows a residential area with streets like "Hwy 401" and "Hwy 404". Overlaid on the map are yellow lines representing "Hwy 401" and "Hwy 404", and a purple line representing "Hwy 401". A legend on the right lists "Locations" with various markers and "Warnings" with a red triangle. Below the legend is a "Active Encounters" gauge showing a value of 2 out of 10, with a "Threshold 7". To the right of the gauge is a "No Features" message. Below the map, there are three panels: "Weather Radar, Toronto" showing a radar map, "Historical Cycle Collected" showing a bar chart with values 1, 1,118, and 1,112, and "OSM Blackbox 3810" showing a speed of 8.07 mph. The bottom left corner features the "esri" logo and the text "Inteligencia Mayor OpenStreetMap".





## GPS Excavation Enroachment Notification System (GPS EENS)

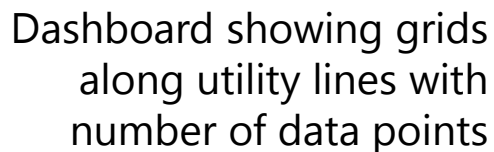
# System Deployment



Devices Installations at PG&E



# System Deployment







## GPS Excavation Enroachment Notification System (GPS EENS)

# Implementation Plan

- Provide key assumptions to estimate "Projected Benefits": including, increased safety, enhance operation, baseline and projected use and cost, and operating conditions.
- Prepare "Production Readiness Plan" to include: critical production processes, targeted market, selected suppliers technologies and capacity, estimated cost of production, and expected investment to reach market.

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**END**