Reducing Excavation Damage in the Gas Industry Using Real-Time GIS

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> Gas Technology Institute

> 2017 Esri User Conference
> Wednesday, July 12, 2017
> 3:15 pm – 4:30 pm
> Room 30A
Overview

> Gas Technology Institute
> What is third party damage?
> Concept: Use Real-Time GIS to Reduce Third Party Damage
> Project Background
> Technology
> Characterizing Movement
> Future Development
Gas Technology Institute

> Independent, not-for-profit established by the natural gas industry

> GTI tackles tough energy challenges turning raw technology into practical solutions

> Downhole to the burner tip including energy conversion technologies
What is Third Party Damage?

> Damage occurring when a contractor strikes an underground utility

> Potential to lead to fatalities, serious injuries, property damage and/or service disruptions

All Reported Incident Cause Breakdown

All Reported Incident Cause Breakdown

Source PHMSA significant incidents Files August 31, 2015
What is Third Party Damage?

According to the Common Ground Alliance, the leading causes of excavation damage are excavators that don’t utilize the one-call center and excavators that dig carelessly near underground pipes.
Use Real-Time GIS to Reduce Third Party Damage

- Take advantage of available technology
- Create a cost-effective platform
- Data is the key
- Provide information, provide awareness
Project Background

- Initial project used individual sensors
  - No cellular communication
  - No Web GIS
  - Post-processed data
  - Expensive $$$$ 

- 2014 Real-Time/GeoEvent Processor
  - Receive/Process data in real-time
  - Use gas system for geofences
  - Provide alerts/awareness to Utility
Project Background

> 2016 – present California Energy Commission (CEC)
  - Work with PG&E to deploy 150 devices
  - Enhance process and data products
    > Deploy supporting system architecture
    > Data analytics
  - Build relationships with contractors
  - Find a commercial partner
Technology Overview

> Build ArcGIS Server/GeoEvent Server Solution hosted on Amazon Web Services

> Develop Android app to send data
  - Cellular communication
  - Motion sensors
  - GPS

> Use GeoEvent Server to receive/process data

> Continuous improvement
  - Software
  - Hardware
Technology – System Overview

WebSocket Message Router → Apache Kafka → Apache Spark

ArcGIS Server ← ArcGIS GeoEvent Processor

Relational Database Storage ← Operations Dashboard
Technology – Black Box Device

- Black Box Device
  - Cellular communications
  - 9DoF Motion Sensor
  - GNSS
  - Audible alarm

- Mounted in excavator
- Powered via lighter plug
- Streams data via WebSocket
Technology – Amazon Web Services

- Elastic Compute Cloud (EC2)
- Relational Database Service (RDS)
  - PostgreSQL SDE Database
- Route 53
- DynamoDB
- CloudFormation
- Esri ArcGIS Server AMIs
Technology – ArcGIS Server

> Current system

  – ArcGIS Enterprise (1 ArcGIS Server instance)
    > Map/Feature Services
  – GeoEvent Server (2 instances)
  – Spatiotemporal Big Data Store (3 instances)
  – WebSocket Router (1 instance)
    > Apache Kafka
      – Messaging platform
    > Apache Spark
      – Data stream processing
Technology – GeoEvent Server

> Two GeoEvent Server Instances
  - (1) ArcGIS 10.4.1
    > Main GeoEvent Model
    > Apache Kafka Connector
  - (1) ArcGIS 10.5
    > Email messaging
    > Spatiotemporal Big Data Store
Technology – GeoEvent Server
Technology – Survey123

> Collect information when a device is deployed
  – Installer
  – Contractor information
  – Equipment type
  – Pictures

> Survey123 had everything we needed

> Access to the Survey123 App
  – Web-based Survey123 registration
Technology – Operations Dashboard

> Provides real-time visualization of activity
Technology – Analytics & Big Data

> Identify activity trends
> Provide overview of hot spots
Technology – Data Processing

> System components to process data
> Receive data
> Process data
> Provide output to multiple sources
Characterizing Movement

> What are the devices doing?
  - Algorithms
  - Machine Learning

> Observation data
  - Teaches the algorithm
  - Characterize movements

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Receive data from field
Monitor for identifiable activity
Process data versus known activity
Characterize excavator movement
Alert Operator and Stakeholders

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Characterizing Movement

> Microelectromechanical system (MEMS)

- **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

Images of MEMS sensor from Bosch Sensortec Website. https://www.bosch-sensortec.com/bst/products/all_products/bno055
Future Development

> Continue developing platform
> Work with commercializers
> Enhance analytic capabilities
> Improve Black Box Device
> Improve characterization capabilities
Questions?