# Exploring Real Time Temporospatial Infrasound Analysis

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## Abstract

Smartphone and IoT sensors allow us to build dense distributed sensor networks that supplement traditional networks. We examine the next-generation technologies powering the acquisition, analysis, and reporting of infrasound data. With the advent of distributed computing, managing data flow from sensor networks has become increasingly complex. Due to the volume, velocity, and variety of data being produced, data acquisition, storage, analysis, and reporting techniques are evolving from single server to distributed computation architectures. In collaboration with Lawrence Livermore National Laboratory, we survey and implement several Big Data technologies to tackle these issues. We implement a system that allows distributed acquisition using Akka actors, a custom time synchronization protocol, intermediate persistent queues with Apache Kafka, long term persistence using a NoSQL database, and real-time analysis and reporting with Apache Spark and Python. We describe how these software components work together to provide acquisition and analysis for recent infrasound signatures as well as preliminary results of our real time analysis, plotting, and product generation components.

### In Two Years

- Over 800 unique smartphone sensors
- Over 40 million audio packets analyzed
- Over 400 gigabytes of infrasound data stored
- Cosmos 1315 Burnup (Christe, UITI 2016)
- DPRK Rocket Launch (Schnurr, UITI 2016)
- Cape Canaveral Launches (Asmar, CVT 2016)

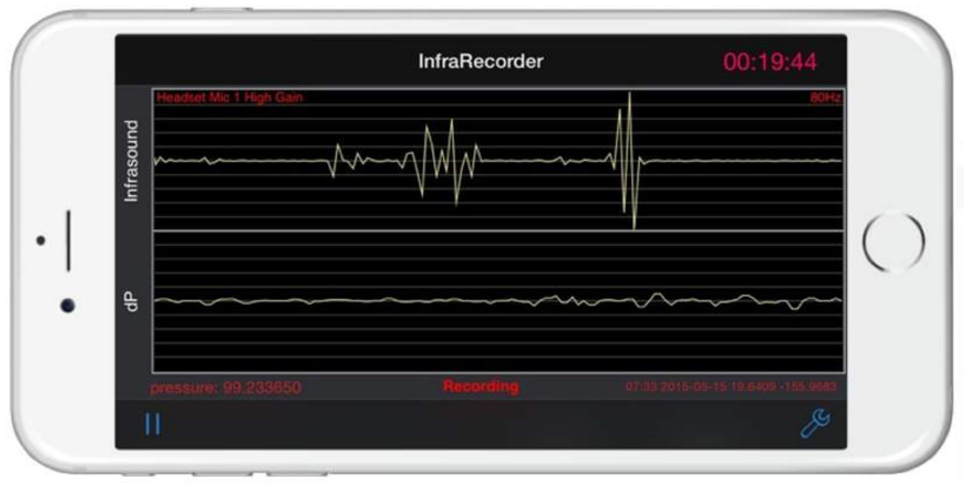


Fig 0. RedVox Recorder iPhone App

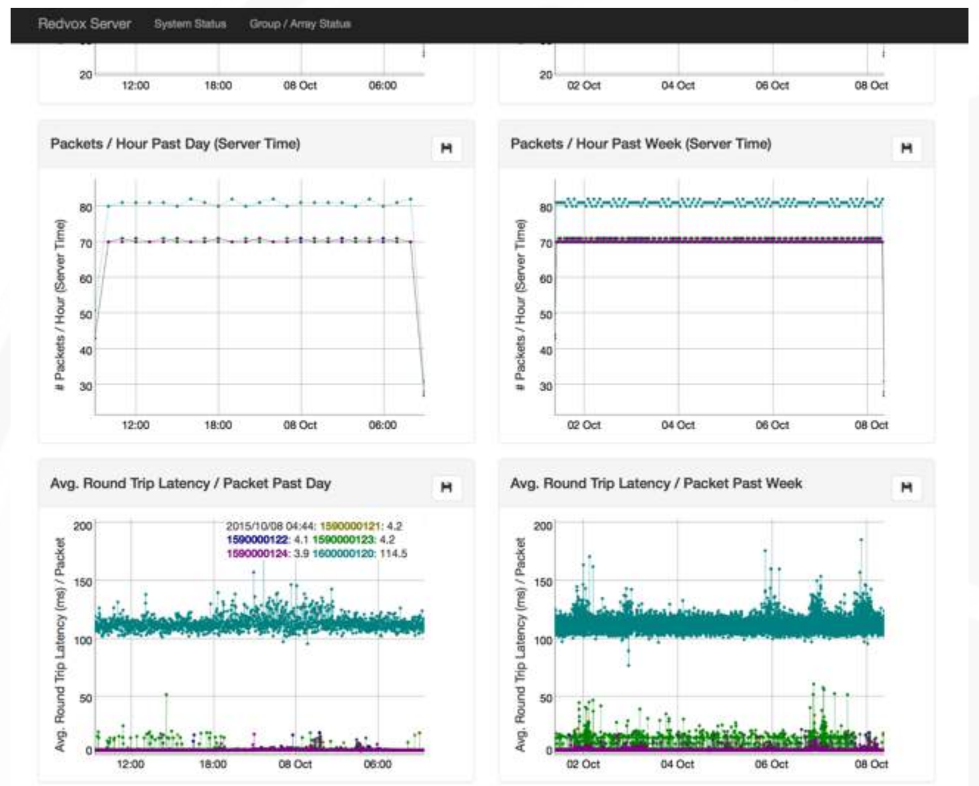


Fig 1. Sensor System Health

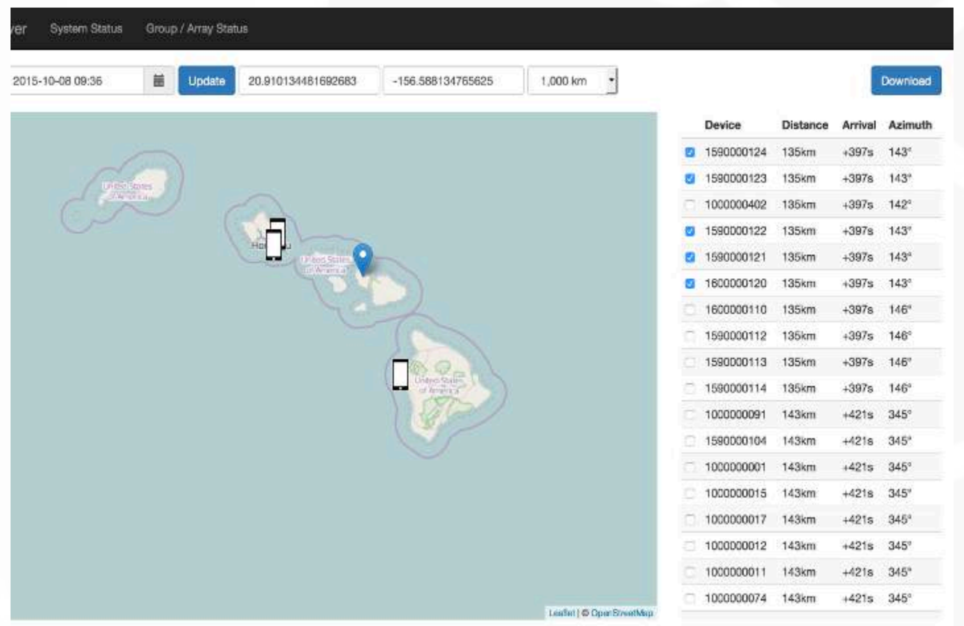


Fig 2. Visual Sensor Listing

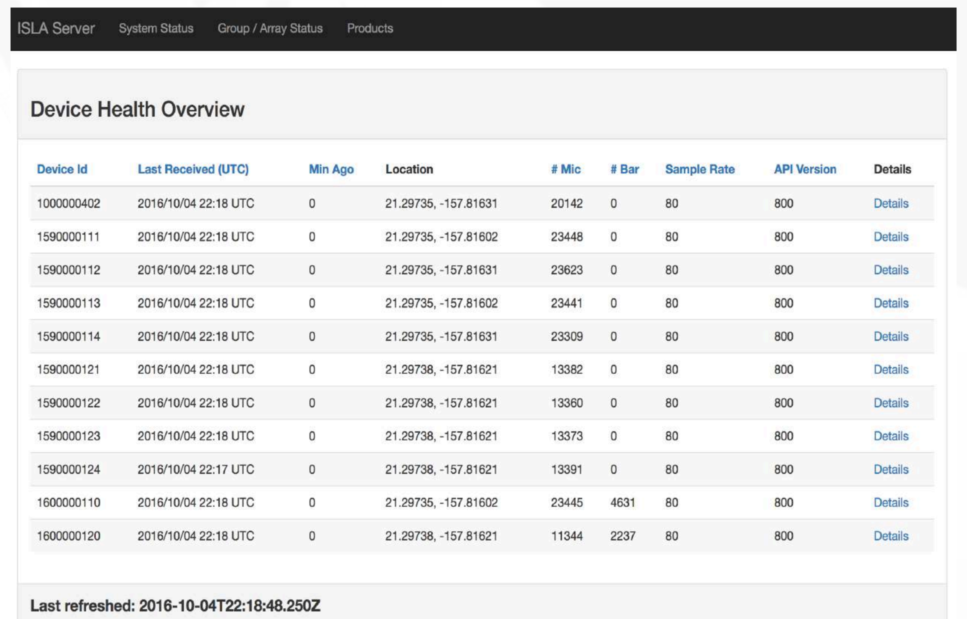
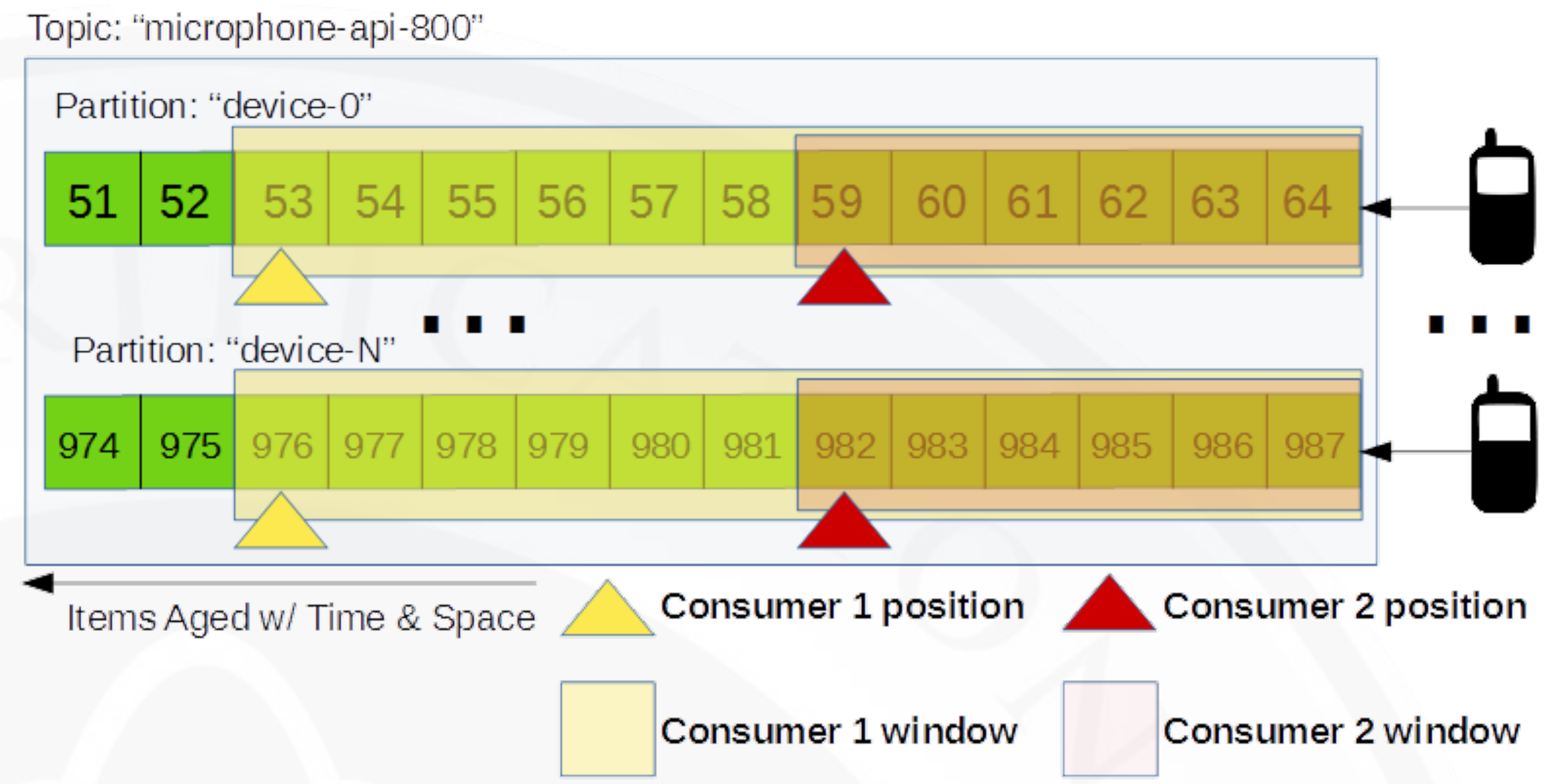


Fig 3. Sensor Details Listing

## Enabling Real-Time Analysis w/ Apache Kafka



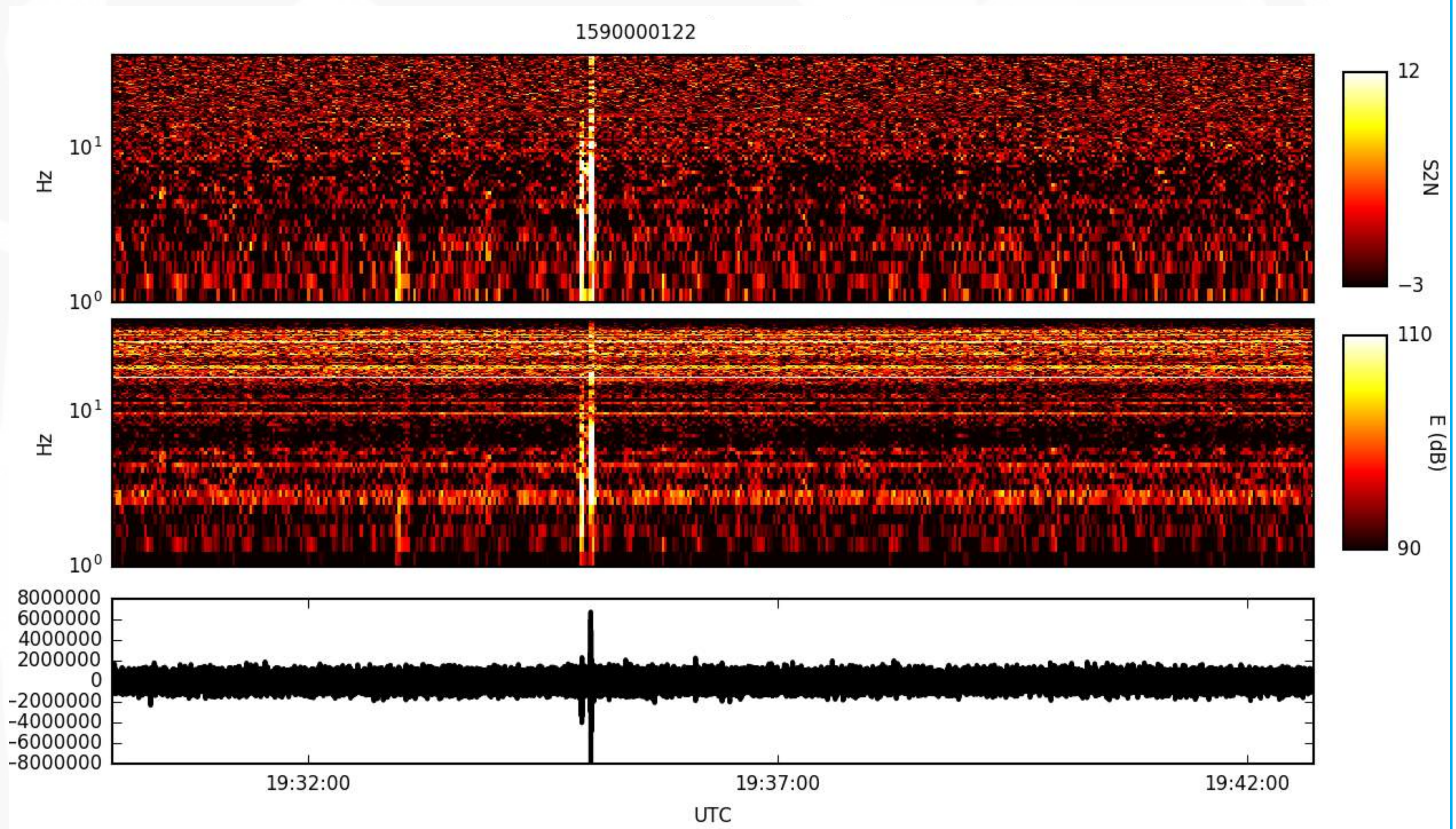



Fig 4. Multiresolution Spectral Analysis of iPod Touch 1590000122

### Total U.S. Sensors Past Two Years

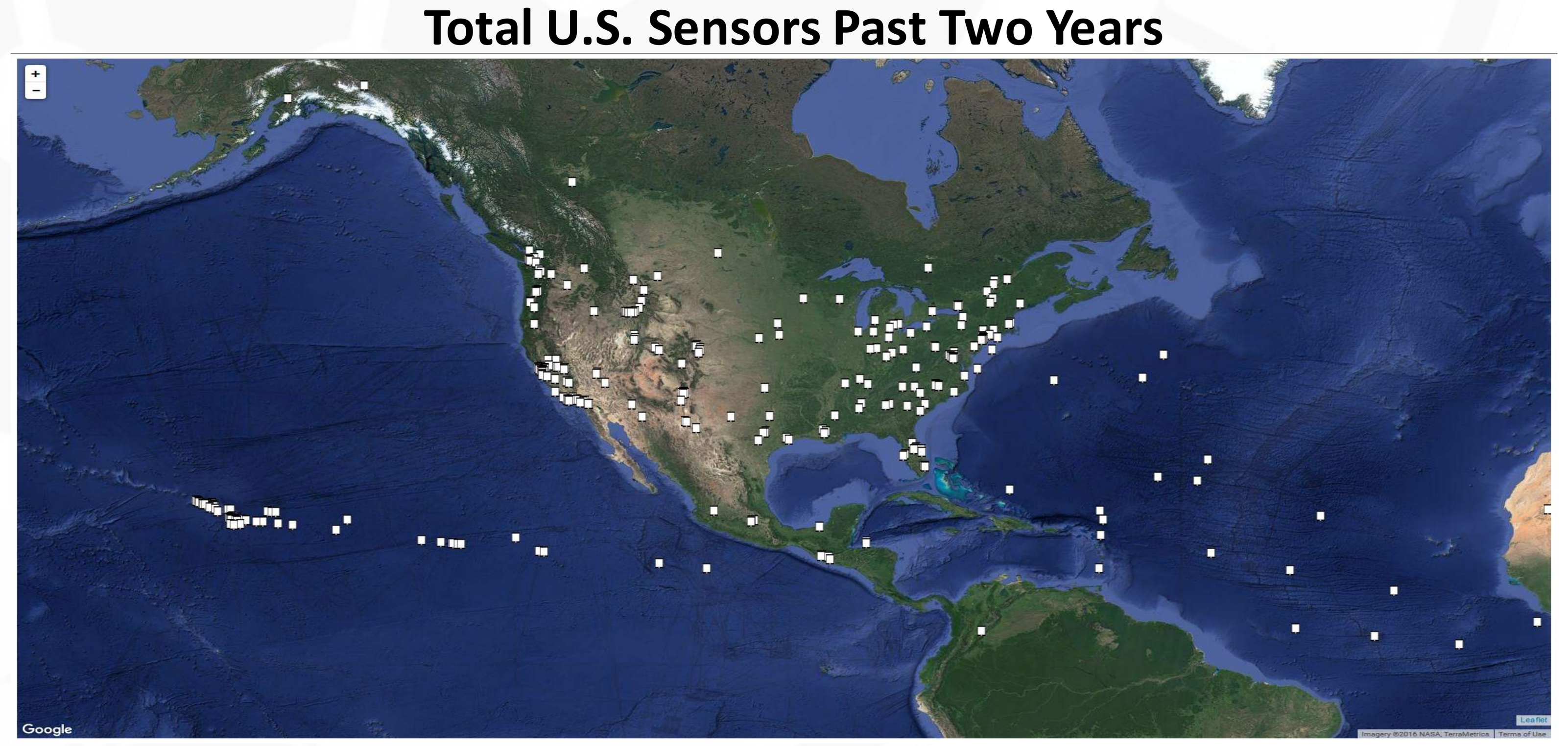


Fig 5. Two Years of U.S. Smartphone Sensors

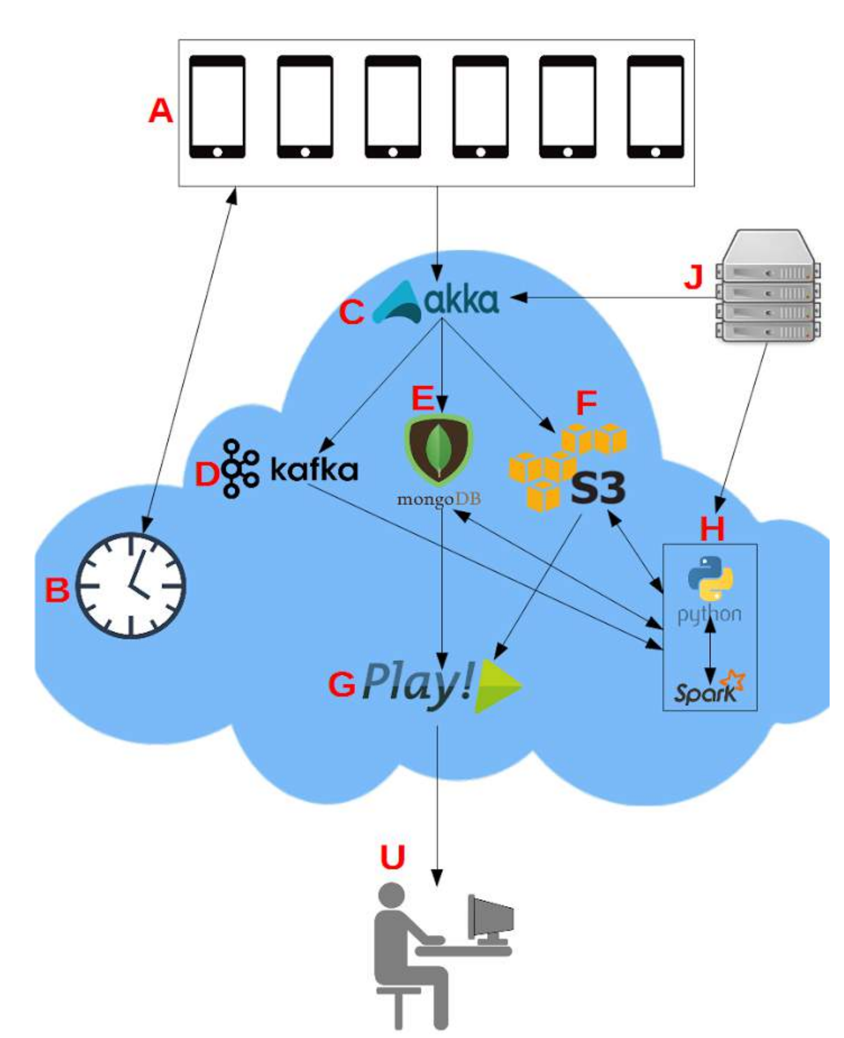
### Issues Faced w/ Traditional Systems

- Server Maintenance / Administration
- Database Availability / Maintenance
- Scalable Analysis
- Scalable Metrics
- Batch Based Analysis

### Lokahi Framework

- Distributed Acquisition
- Distributed Real-Time Analysis
- Distributed Persistence
- Distributed Metrics / Data Access

### Lokahi Framework




A. Distributed Sensors
B. Custom Time Synchronization
C. Distributed Data Acquisition
D. Distributed Data Buffer
E. Distributed Persistence (Meta-Data)
F. Distributed Persistence (Payload)
G. Web Server / System Health Metrics
H. Distributed Analysis
J. Legacy Sensor Systems

Fig 6. Lokahi Framework

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