Mobile, Interoperable, Near Real-time Sensor Networks:
Two Consecutive Case Studies in Combining Geospatial Standards with Proprietary Software through Custom Development

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ORNL, GIST, SensorNet

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- **ORNL**
  - **Oak Ridge National laboratory**
    - **Department of Energy National Laboratory located in East Tennessee**
- **SensorNet**
  - **Program within the Computer Science and Engineering Division of ORNL**
    - **Responsible for funding, and major contributors to, presented projects**
- **GIST**
  - **Geographic Information Science and Technology Group**
    - **A group within the Computer Science and Engineering Division of ORNL**
      - **Major contributors to presented projects**

Working with Zekiah

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- **Benefits for ORNL**
  - **Expanded our technical expertise**
  - **Local presence in DC for this project**
    - **Became more important near the end of the project and through into its maintenance**
  - **Expand number or contributors easily during rush portions of the project**
    - **Zekiah is prepared to expand project presence quickly to ensure success**
  - **Allowed ORNL to provide assurance to the sponsor that there would be someone local, that they could contract to, who was capable of maintaining the system**
    - **ORNL is great for research but not well positioned for long term maintenance**
- **Benefits to Sponsor**
  - **Local presence they know and feel good about contacting**
    - **We have worked together throughout the project so Zekiah reps are known and trusted participants**
  - **Easy of transition from project to maintenance**
    - **Zekiah has been participating and interacting with the client throughout the project which makes the transition easy for everyone**
  - **Potential source for commercialization of system**
    - **If the JFHQ wants to take this to another level, they already have a known entity that knows the system to work with**

Systems Overview

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- **SNAPS 1.0**
  - Mobile SensorNet System (Actually in a trailer)
  - Geospatial Visualization Capabilities
  - GPS enabled Radiation, Chemical, Weather, and Video Sensors
  - HPAC Integration
- **SeaHawk**
  - SRRPP project based in the SeaHawk program at the Port of Charleston
  - Land and Marine based SensorNet Systems
  - Vehicle and Officer GPS Tracking
  - GPS enabled Radiation, Video
- **SNAPS 2.0**
  - Major Improvements to the existing SNAPS System

SNAPS 1.0 – Direct WFS Insert

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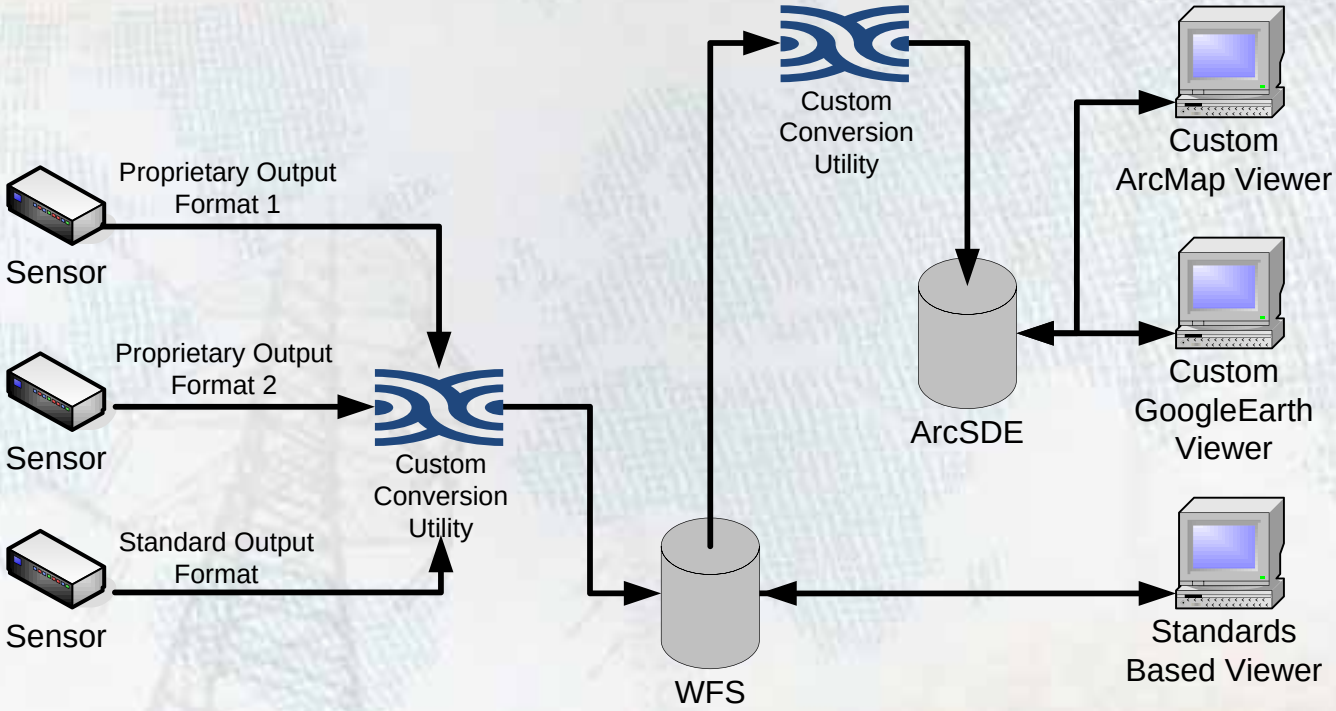

Why is Direct WFS is Problematic

- **Where standards work well and where they don't work**
  - **Great for making all of the sensors look standardized**
  - **Not great as an internal data transmission format…**
- **Intrinsic problems include**
  - **Data is duplicated**
  - **Two conversion processes to maintain**
  - **Performance Issues**
    - **Both WFS and ArcSDE are bottlenecks compared to direct database interaction. Together, they can really hinder performance**
    - **The conversion to ArcSDE caused a large number of reads on the WFS. This had a negative impact on the overall performance of the system. More reads per second means less writes per second**
    - **Inserting data into ArcSDE is significantly slower than inserting data directly into a database**
      - **We found that ArcObjects inserts were faster than SDE API inserts**
      - **Querying against the data tables directly in SQL Server to gather data used in the conversion process, rather than going through SDE, is a good shortcut**
- **Conversion process can be used for other tasking that would otherwise require an additional WFS call**
    - **Alerting and interfacing with other systems (cameras for example)**

SeaHawk – Initial Parallel Insert

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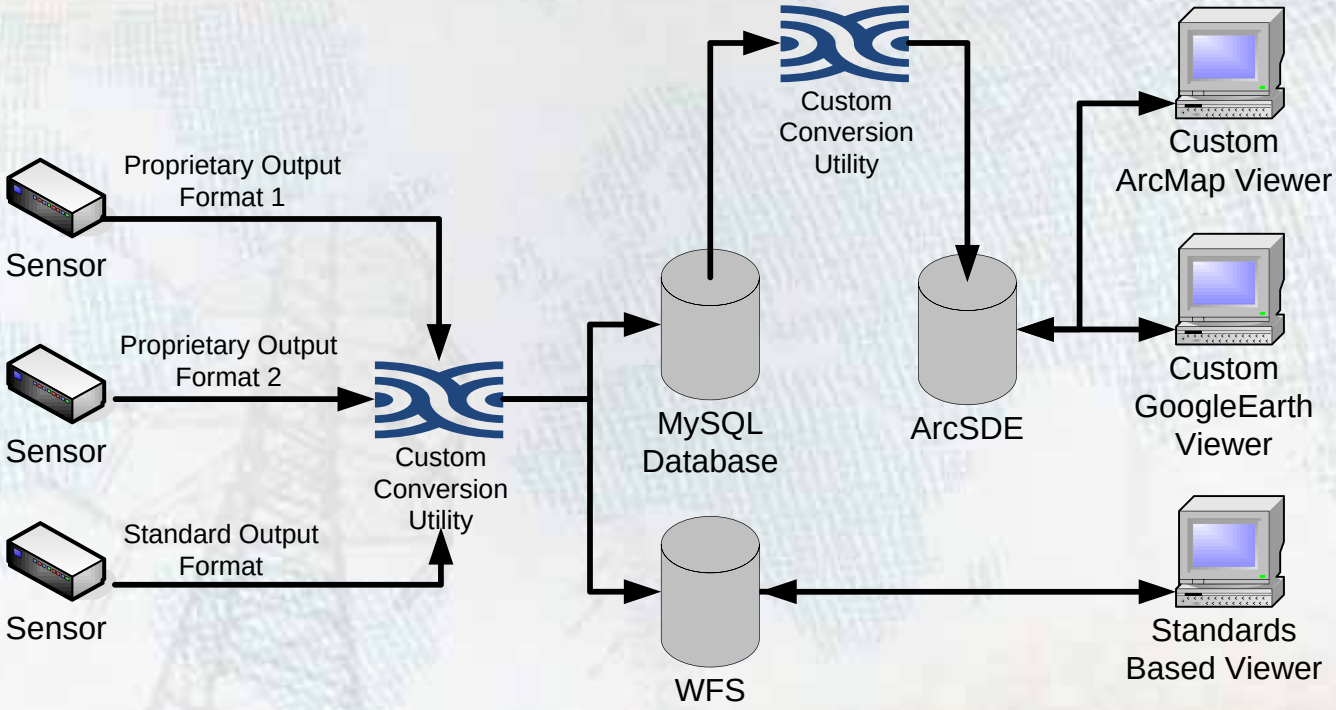

Benefits of Parallel Insert

- **Intrinsic problems include**
  - **Data is still duplicated**
    - **There is no other option in this system…**
  - **Two conversion processes to maintain**
    - **There is no other option in this system…**
  - **Inserting data into SDE is still slower than into a traditional DB**
    - **Not likely to get around that one…**

- **Improvements**
  - **Performance Issues Significantly Improved**
  - **Data is inserted into the WFS in parallel with the data being inserted into the MySQL database which removes the WFS related delay in pushing data to SDE**
  - **Reads from MySQL were significantly faster than from the WFS and created significantly less of a bottle neck**
  - **Conversion process can still be used for other tasking that would otherwise require an additional DB call**

SNAPS 2.0 – Enhanced Parallel Insert

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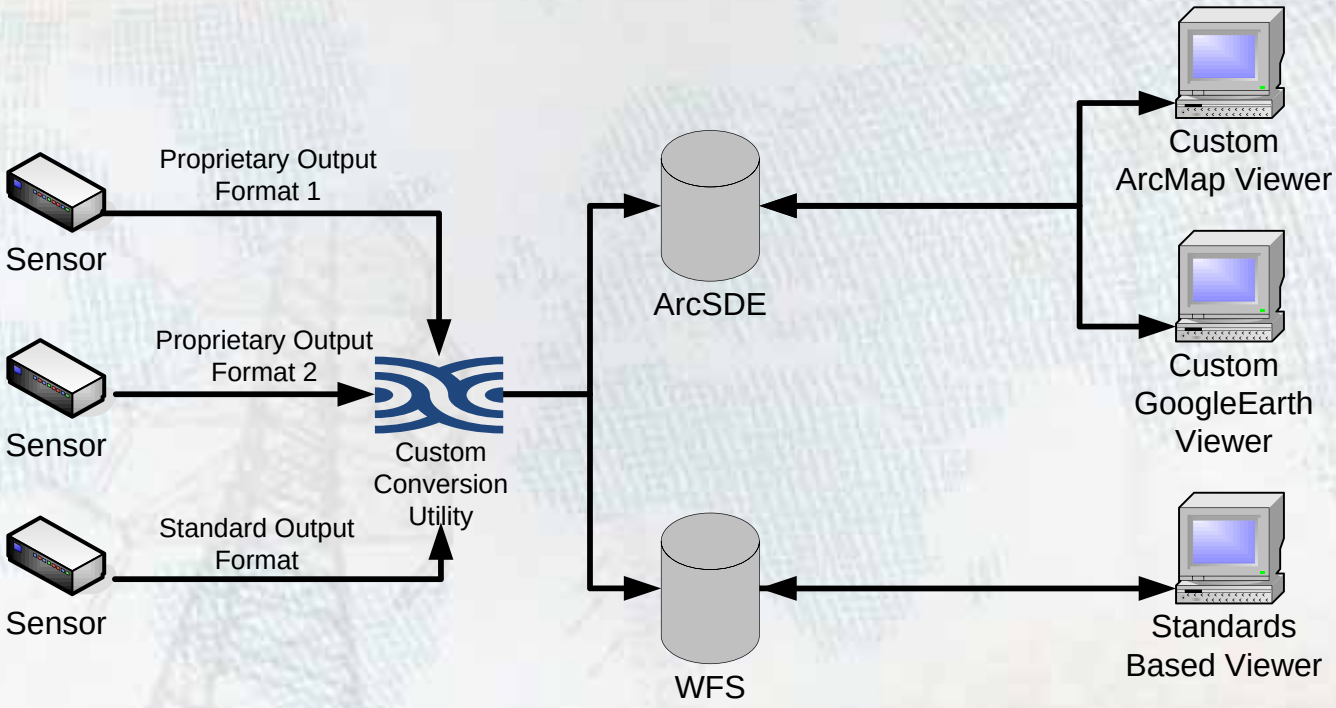

Parallel Insert Mechanism Design

- **WFS "Proxy"**
  - **Web application that receives WFS-T requests from node server**
    - **Performs custom validation**
    - **Forwards request to WFS**
    - **Formats inserts and pushes onto message queue for ArcSDE insert**
    - **Sends WFS responses back to node server**
  - **Appears to be a true WFS server to node servers**
- **Message queuing service**
  - **Windows service that creates, starts and manages message queues**
    - **Separate message queue for each message type**
    - **Each queue runs in its own thread**
  - **Service creates an instance of a manager object for each queue**
    - **Drains queue of waiting messages**
    - **Creates and inserts alert/observation/sensor features and inserts into feature class**
    - **Moves historical data to history table**

Benefits of Enhanced Parallel Insert

- **Intrinsic problems include**
  - **Data is still duplicated**
    - **The only purpose to the duplication is to provide the WFS access**
  - **Inserting data into SDE is still slower than into a traditional DB**
    - **Not likely to get around that one…**

- **Improvements**
  - **Performance Issues Significantly Improved**
  - **Down to one conversion processes to maintain**
  - **WFS is inserted in parallel to the SDE insert which removes any delay in pushing data to SDE that was associated with that process**
  - **No more reading from a WFS or a database**
    - **Unless you want to…**
  - **Conversion process can still be used for other tasking that would otherwise require an additional DB call**
  - **Flexible process supports many type of data insertion**
  - **Expandable design supports addition of new queues and message types**

SNAPS Geospatial Viewer

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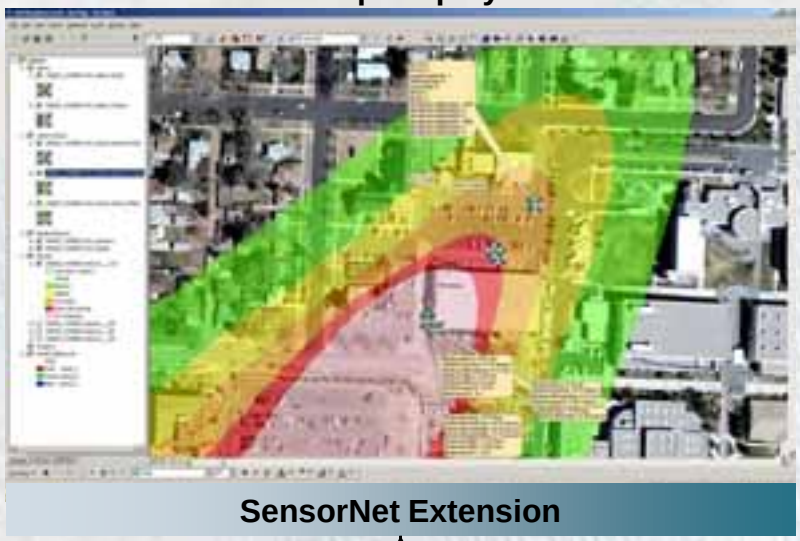
ArcMap Display



SensorNet Extension

Timed refresh of display (spatial data only)

Web Services

(Camera control, Plume Models)

Sensor status, alert confirmations

Inserts via WFS (Alerts, Observations, Plumes, etc.)

ArcSDE

SQL Server

Geospatial Viewer Design

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- **Situational awareness interface for sensor alerts and observations**
- **Developed as an ArcMap extension**
  - **Developed in .Net using C#**
  - **Spatial data from ArcSDE connection**
  - **Non-spatial data via ADO.NET**

- **Provides controls to:**
  - **Manipulate cameras onboard SNAPS vehicle**
  - **Acknowledge and manage alerts from sensors**
  - **Monitor sensor status**
  - **Run plume models via web services**
  - **Manage labeling options**
  - **Manage display refresh rate**

- **Periodically refreshes display from ArcSDE database**
  - **Database is populated with data from WFS**

Application of Design in Future Systems

- **ORNL/Zekiah working together to improve/apply the design**
  - **Major design improvements make this work easy to use on other projects**
  - **Shelby County Fusion Center**
    - **Data from a mobile system developed based on the SNAPS I design, data from other sensor systems in Memphis area, camera systems, and disparate intelligence databases**
      - **Somewhat similar configuration to SNAPS I**
    - **Taking advantage of improved insert mechanism to bring in a variety of data types**
    - **Taking advantage of Google Earth development to provide data in multiple interfaces**
  - **Kentucky Information Fusion Center**
    - **Data from multiple weigh station based sensor platforms, camera systems, near real-time tracking, and disparate intelligence databases**
      - **Very different from SNAPS I**
    - **Taking advantage of improved insert mechanism to bring in a variety of data types**
  - **Appropriate use of OGC standards is one key to integration**
    - **Need to identify where they work well**
      - **Communication of alerts from sensor to server**
      - **Data sharing and mobile units**
    - **Also need to identify where they don't work well**
      - **Camera control**
      - **Sensor status**
      - **Standard web services more appropriate here**

Closing

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