An Open Geospatial Consortium-based Arctic Climatology Sensor Network Prototype

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Study Area: Barrow, Alaska

- “Top of the world”, Point Barrow Alaska, is the nation’s northernmost point.
- One mile away lies the city of Barrow, the northernmost settlement on the continent.
- Less than 4,000 people live in the area.
Project Objectives

• Create Data Information System
• Use Open Geospatial Consortium (OGC) Standards
• End to End Geographic Information Network
Motivation

- Interoperability
- Scalability
- Extensibility

Ultimately,

internet based stationary and mobile location and time aware sensor networks
Direction

- TCP/IP
- Microsoft Windows
- File Transfer Protocol
- ESRI, ArcGIS Server
- SQL Server

Partnerships

- INTRUST Group Inc.
- Linoma Software
- Stratus Technologies
- DAVIS
Prototype GIN Network
Remote Server Virtualization

Avance

High Availability software created by Stratus
Has Xen Server Virtualization software embedded within Avance
Automated Data Movement

Linoma Software
Go Anywhere Director
streamlines and manages data movement through an innovative centralized approach. It allows your organization to connect to almost any system (internal or external) and securely exchange data using a wide variety of standard protocols.
Data Flow

Challenges

- Non-OGC xml file
- Connectivity
- Non-unique files
- Connectivity and Latency
- Parsing Data and Conversion
- OGC Compliant Database

Solutions

- Sensor
- Arctic FTP Server
  - Batch File to name sensor files
  - GoAnywhere Automation
  - Stored Procedures called
- Cincinnati Server
  - SQL Server
Original XML File

```xml
  <data timeframe="actual">
    <item sensor="date0" cat="date" unit="utc">20090810234001</item>
    <item sensor="date0" cat="date2" unit="utc">10.08.2009 23:40:01</item>
    <item sensor="date0" cat="puredate" unit="utc">10.08.2009</item>
    <item sensor="date0" cat="time" unit="utc">23:40:01</item>
    <item sensor="date0" cat="year" unit="utc">2009</item>
    <item sensor="date0" cat="month" unit="utc">08</item>
    <item sensor="date0" cat="day" unit="utc">10</item>
    <item sensor="date0" cat="dayofweek" unit="utc">1</item>
    <item sensor="date0" cat="hour" unit="utc">23</item>
    <item sensor="date0" cat="min" unit="utc">40</item>
    <item sensor="date0" cat="sec" unit="utc">01</item>
    <item sensor="date0" cat="date" unit="local">20090810234001</item>
    <item sensor="date0" cat="date2" unit="local">10.08.2009 23:40:01</item>
    <item sensor="date0" cat="puredate" unit="local">10.08.2009</item>
    <item sensor="date0" cat="time" unit="local">23:40:01</item>
    <item sensor="date0" cat="year" unit="local">2009</item>
    <item sensor="date0" cat="month" unit="local">08</item>
    <item sensor="date0" cat="day" unit="local">10</item>
    <item sensor="date0" cat="dayofweek" unit="local">1</item>
    <item sensor="date0" cat="hour" unit="local">23</item>
    <item sensor="date0" cat="min" unit="local">40</item>
    <item sensor="date0" cat="sec" unit="local">01</item>
    <item sensor="lunar" cat="phase" unit="percentage">78.2</item>
    <item sensor="lunar" cat="phase" unit="segment">5</item>
  </data>
```
Normalization

<table>
<thead>
<tr>
<th>GA</th>
<th>Weather *</th>
<th>Weather_History *</th>
</tr>
</thead>
<tbody>
<tr>
<td>timeframe</td>
<td>date</td>
<td>date</td>
</tr>
<tr>
<td>sensor</td>
<td>time</td>
<td>time</td>
</tr>
<tr>
<td>cat</td>
<td>longitude</td>
<td>longitude</td>
</tr>
<tr>
<td>unit</td>
<td>latitude</td>
<td>latitude</td>
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<tr>
<td>item</td>
<td>elevation</td>
<td>elevation</td>
</tr>
<tr>
<td></td>
<td>location</td>
<td>location</td>
</tr>
<tr>
<td></td>
<td>serialnumber</td>
<td>serialnumber</td>
</tr>
<tr>
<td></td>
<td>MACAddress</td>
<td>MACAddress</td>
</tr>
<tr>
<td></td>
<td>sunrise</td>
<td>sunrise</td>
</tr>
<tr>
<td></td>
<td>sunset</td>
<td>sunset</td>
</tr>
<tr>
<td></td>
<td>temp</td>
<td>temp</td>
</tr>
<tr>
<td></td>
<td>humrel</td>
<td>humrel</td>
</tr>
<tr>
<td></td>
<td>dew</td>
<td>dew</td>
</tr>
<tr>
<td></td>
<td>heatindex</td>
<td>heatindex</td>
</tr>
</tbody>
</table>
Spatial Data Relationship

Sensors *
- sensorname
- sensorotype
- latitude
- longitude
- elevation
- direction
- location
- geometry_column

Weather *
- date
- time
- longitude
- latitude
- elevation
- location
- serialnumber
- MACaddress
- sunrise
- sunset
- temp
- humrel
- dew
- heatindex
ESRI OGC Participation

Principle Member
Actively Participates
- Technical Committee
- Planning Committee
- Board of Directors
- All three OGC programs
  - Interoperability, Standards, Community
- Architecture Board
- Others...
Figure 3: Schema for feature tables using SQL with Geometry Types
Visualization

Web Mapping Application

Results
Map Controls

Barrow
- power_poles
- power_poles_2
- covewater
- air
- forest_2008
- tree_water
- roads

Results
Map Controls
Keyhole Markup Language (KML)

Supported by ArcGIS Server as an output format
Adding Imagery Geoinformatics
Network Monitoring

Company Name: Arctic Networks
Report: Detailed Status
Period: 12 Hours
Start Date and Time: 2009-Sep-07 09:00
Device: 199.169.76.161
Service: Connectivity

Date | State | Elapsed Time
--- | --- | ---
2009-Sep-07 09:00 |  | 2 Hour(s) 22 Minute(s) 1 Second(s)
2009-Sep-07 11:22 |  | 4 Minute(s) 37 Second(s)
2009-Sep-07 11:26 |  | 10 Minute(s) 51 Second(s)
2009-Sep-07 11:37 |  | 4 Minute(s) 43 Second(s)
2009-Sep-07 11:43 |  | 25 Minute(s) 59 Second(s)
2009-Sep-07 12:00 |  | 16 Minute(s) 25 Second(s)
2009-Sep-07 12:24 |  | 4 Hour(s) 25 Minute(s) 0 Second(s)
2009-Sep-07 16:49 |  | 5 Minute(s) 10 Second(s)
2009-Sep-07 18:54 |  | 5 Minute(s) 26 Second(s)
2009-Sep-07 17:00 |  | 5 Minute(s) 4 Second(s)
2009-Sep-07 17:05 |  | 2 Hour(s) 22 Minute(s) 58 Second(s)
2009-Sep-07 19:29 |  | 5 Minute(s) 10 Second(s)
Questions?