The Speaker

• Austin McHugh (presenting)
  – Twenty years with CSI dataloggers, first as a customer at the University of Maine for 2 years as Research Associate, 17 years at CSI as an Applications Engineer, 2 years with GWS as Research Engineer, again as a customer or user.
The Co-Author

• Dennis Anderson
  – CSI Director of Business Development, RWIS product development. 25+ years at CSI with a full range of experience in customer service, manufacturing, system integration, data program development.
Definition of Terms

- ITS – Intelligent Transportation System
- Rural – away from AC power or common high speed telecommunications, costly access
- RPU – Remote Processing Unit or datalogger are the same, synonymous
Definition of Terms

- RPU or datalogger functions
  - Measure sensor signals (analog, serial, etc.)
  - Record reading
  - Process, calculate, store output data
  - Communications in and out
  - Control devices
Definition of Terms

• Telemetry or telecommunications (communication) – link to the remote datalogger or RPU

• NTCIP – National Transportation Communications for ITS Protocol

• Compliant vs. non-compliant – NTCIP ESS
Agenda

- **Rural Data Needs**
- Rural Data Challenges
- Rural Data Challenge Solutions
- Networking Break (15 min.)
- Rural Data Components
- Cost Issues
- Real-World Examples
- Summary
Rural Data Needs

- Road weather, traveler safety
- Road pavement conditions
- Road temperatures for load limits
- Avalanche forecasting
- Bridge pier scour monitoring
- Bridge and structural monitoring
- Flood monitoring, water levels
- Visibility monitoring
Agenda

- Rural Data Needs
- **Rural Data Challenges**
- Rural Data Solutions
- Networking Break (15 min.)
- Rural Data Components
- Cost Issues
- Real-World Examples
- Summary
Rural Data Challenges

- Telemetry
- Power
- Measurement Flexibility
- Operation and Maintenance
Rural Data Solutions

- Telemetry
- Power
- Measurement Flexibility
- Operation and Maintenance
Telemetry

Multiple PCs to multiple RPU's flexibility

Any NTCIP compliant software

LoggerNet via NTCIP and/or other standards

internet

RPU-1

RPU-2

RPU-3

RPU-4
Telemetry

- Spread Spectrum Radio
  - Freewave radio compatible
- VHF/UHF
- GOES satellite
- Other satellites including LEOS (GlobalStar)
Denali National Park road, AK road temperature, moisture, snow depth
Telemetry

• Phone
  – POTS (Plain Old Telephone Service)
  – Wireless cell phone
• Ethernet
  – Via radio Airlink Raven or
  – Wire serial servers
• Combinations
• Power needs must be considered with telemetry
Telemetry Options

Campbell Scientific, Inc. data collection options
Rural Data Solutions

- Telemetry
- **Power**
- Measurement Flexibility
- Operation and Maintenance
Power

• Storage
  – Batteries

• Sources
  – Solar panel
  – Wind turbine
  – Propane
    • High initial cost and O and M
  – Diesel
    • High initial cost and O and M
  – Hybrid
Power

• Power supply examples; batteries and solar panels
  – Lower power
    • 7AHr battery with 10 watt solar panel
    • Good solar exposure
    • Minimal system current needs
  – Higher power need
    • Two 80AHr batteries, 10 amp regulator
    • 60 watts of solar panel
  – Worse case
    • Heated enclosure
    • 100’s of watts of solar panel or other power sources
Power

- Depends on the total load – the average current drain
  - Sensors
    - Passive or active
    - 2-10’s of ma
  - Datalogger (RPU)
    - 2ma
  - Telemetry
    - 5-100ma or more
  - Pucks, visibility, present weather, cameras
    - 100’s of ma
  - Heaters
    - Amps!
    - Non-heated equipment essential
Cottle Island, AK (Beaufort sea network)
Cottle Island, AK (Beaufort Sea network)
Cottle Island, AK (Beaufort Sea network)
Rural Data Solutions

- Telemetry
- Power
- **Measurement Flexibility**
- Operation and Maintenance
Measurement Flexibility

- Multiple data standards
- Multiple data tables
- Users can add any type of sensor
- Computations
- Control ability
Measurement Flexibility

- Logger can measure any type of signal
  - Volts, pulses, resistance, current, RS232, RS422, RS485
- Wind Speed and Direction
- Air temperature and relative humidity
  - Computations
    - Dew point
    - Wind chill
    - Etc.
Measurement Flexibility

• Barometric Pressure
• Present Weather
  – Campbell Scientific Limited PWS100 (visibility)
  – Vaisala PWD22 (visibility)
  – Ott Parsivel
• Non-intrusive road condition
  – IDI Icesight 2020
  – Vaisala DSC111
Measurement Flexibility

- Lufft IRS21 Intelligent Road Sensor
  - Road temperature
  - Residual salt content and calculation of freezing temperature
  - Road surface condition – dry, moist, wet, ice, snow
  - Water film level
  - IRS31 Active sensor currently under evaluation
Measurement Flexibility

• Precipitation
  – Frozen or liquid
  – Weighing
  – Lufft Radar Rain Sensor
• Various temperature strings
  – Thermistors
  – Digital strings
    • Beaded Stream
Measurement Flexibility

- Traffic
  - Counting
  - timing
Measurement Flexibility

• Expansion with multiplexers
  – Many of the same type of sensors
  – To one channel on the logger
Cameras

• CSCC CC640
• Others possible (night view)
Image of L145Lake station from L145 Shore Station plus shadow
Networking Break

• 15 minute break
• Please Attend ITS-Alaska Annual Meeting!
  – Friday, 1:30pm, Voyager Room
Agenda

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- **Rural Data Components**
- Cost Issues
- Real-World Examples
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Rural Data Components

- Data Collection Software
- Mounting
Data Collection Software

Multiple PCs to multiple RPUs flexibility

- Any NTCIP compliant software
- LoggerNet via NTCIP and/or other standards

NTCIP: Network Time Clock in Protocol

LoggerNet: Data Collection Software
Data Collection Software

- NTCIP
- Compliant with ESS (Environmental Sensors Station)
  - 1204 Version2 (current accepted standard)
- NTCIP in datalogger (field side)
- NTCIP in LoggerNet 4.0 (server side)
  - RWIS Administrator (feature of LN) will query other NTCIP compliant stations
Data Collection Software

- LoggerNet with NTCIP RWIS Administrator
  - Polls NTCIP compliant hardware
- LoggerNet
  - Also polls the datalogger’s non-NTCIP data
    - Wind rose, others
- Customer owns the data to be modified or redistributed
- Hardware compatible with compliant software
Data Collection Software

• Other compliant software can access CSI hardware
  – Petersburg
• ScanWeb to collect CSI hardware
• User-built
  – Open architecture, CRBasic, custom displays
  • Kentucky
Data Collection Software

- Data flexibility on the RPU
  - RWIS/NTCIP Compliant
  - Customer in Control Technologies
  - CCT System philosophy
  - Multiple data standards from one logger (NWS, USGS, FAA, NOAA)
Rural Data Components

• Data Collection Software
• Mounting
Mounting

- Towers
- Tripods
- Other structures
- Sensor and hardware mounting
Three of many mounting structure options

30’ Tower

10’ Tower

10’ Tripod
Other Structures

- Not limited to a few options
- Infinite combinations as shown in many presentation photos
- Other manufacture’s towers, structures, railings, and enclosures
Sensor and Hardware Mounting

- Solar radiation platform
- 90° pipe brackets
- 90° bracket with pipe
- 90° mount
- Angle and azimuth pipe bracket
- 1” pipe used on most mounts
Agenda

• Rural Data Needs
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• Rural Data Solutions
• Networking Break (15 min.)
• Rural Data Components
• **Cost Issues**
• Real-World Examples
• Summary
Cost Issues

- Initial Equipment, installation, testing
- Operation and Maintenance
- Upgrades
- Cost Examples
Initial Equipment, installation, Testing

- Objectives, site location, permitting, ordering
- Equipment pre-testing, field mobilization, installation, demobilization
- Communication and sensor verification, initial data reporting
Operation and Maintenance

- Annual or semi-annual site checks
- Sensor recalibration testing and/or field replacement
- Station, sensor repairs
  - Weather, icing, high winds, etc.
  - Vandalism (human, animal, pests)
  - Other (geotechnical, infrastructure changes)
Upgrades

- Changing station objectives
- Changing station partners
- New sensor technology
- Increased power costs
- New, changing telemetry options, needs
- O/M budget constraints
- Life expectancy replacement
Cost Examples

- CSI offers compatible RPU replacement
  - For existing non-CSI compliant or non-compliant networks
  - Drop-in option
    - Example UTDot (Sherwood Hills)
Cost Examples

• Simple image and air temperature
  – Phone telemetry
    • $6400
Cost Examples

Simple low cost station
Temperature and image
Cost Examples

- Air Temperature
- Solar Panel
- CC640 Camera
- Tripod option
Cost Examples

Tower option
Cost Examples

• Complete NTCIP-compatible RWIS station
  – CR1000 datalogger
  – Power supply and battery backup
  – Tower, base, and guy kit
  – Two road pucks
  – Present Weather Sensor
  – Met Sensors (wind speed/direction, air temperature, relative humidity, precipitation)
  – Camera

• Equipment cost only -- $37,000
Cost Examples

I 70, Utah

09/23/2005
Cost Examples

• Still needed to Complete a Full RWIS
  – Telemetry
  – Assumed AC available
    • Solar panels
Agenda

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• Break
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Alaska DOT

- Petersburg, AK Blaquier Point
  - Designed by Haight and Associates, Juneau, AK
  - Multi-use with compliant and non compliant
  - Voice phone-modem to hear current wind conditions
- Telemetry Details
  - Complex telemetry
  - CR10X/NL100 are the NTCIP RPU
- Polled by SSI ScanWeb
Map of Freewave telemetry links from Blaqueire Pt. to Wrangel base station
Blaquiere Point, Petersberg, AK
**Alaska's Road Weather Information System**

**RWIS Site Summary**

Mitkoff Highway @ Blaquiere Point MP 33

For definitions, click on the name field.

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<tr>
<th>Date / Time</th>
<th>07/24/2008 7:48 AM</th>
</tr>
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<tbody>
<tr>
<td>Air Temperature</td>
<td>52 °F</td>
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<tr>
<td>Wind Speed</td>
<td>1 mph</td>
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<tr>
<td>Wind Direction</td>
<td>S</td>
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<tr>
<td>Wind Speed Maximum</td>
<td>4 mph</td>
</tr>
<tr>
<td>Wind Direction of Maximum Speed</td>
<td>S</td>
</tr>
<tr>
<td>Station Barometric Pressure (non-aviation)</td>
<td>-</td>
</tr>
</tbody>
</table>

**Camera Data**

Wrangell View from Banana Point MP 21.5
07/24/2008 8:45 AM

http://www.dot.state.ak.us/wwa/roadweather/forms/SiteSum.html?areaId=5&perspectiveId=18&siteId=152 (1 of 2) [7/24/2008 9:31:38 AM]
Yukon Territories

• 3 CSI RWIS Stations
• CSI BlackTop software to RoadAware
Yukon RWIS, Fish station
AKDOT road temperature network

- Temperature profile network
- Regulating road weight restrictions
- 25+ stations
Kentucky DOT

- LoggerNet to National Instruments LabView
- Operating since 1996 before NTCIP
- http://www.kytc.state.ky.us/RWIS/
- Glenn Anderson
Kentucky Roadway Weather Information System (RWIS)

Click on the blue dots to display the weather data
KY RWIS - Station Data

Location
1-75 at KY 36 - Williamstown

Last Updated
02:20 PM EST
08/31/08

Last Sample
02:15 PM
08/31/08

Data Age
6 min

Wind
N

Direction
S

Current Temperatures (F)
Air
Pavement
Subsurface
87.5
107.4
83.6

Legend:
AIR
DEWPOINT
PAVEMENT
SUBSURFACE

Last 12 Hours

Solar Rad.

0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
8.50
9.00
9.50
10.00

03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00

Precip
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50

Precip Today
0.00

Surge Protector OK
Cabinet Humidity OK
Battery OK

Back
Tooelle County, UT

- Example of open architecture combining more than one entity’s needs
- Loggers are polled for compliant and non-compliant data
- Lufft pucks and rain gages added to existing county network of 27 stations
UT DOT

- Multiple manufactures’ servers
- Multiple RWIS hardware manufacturers
- Replacing retired other-manufacture’s hardware with CSI
- Lufft pucks
- Moving towards exclusive use of LoggerNet and RWIS Administrator
Quebec, CA

- 17 new stations to 50 total
- CSI CR5000 dataloggers
- Lufft road surface condition puck sensors
Iceland

- http://www.vegagerdin.is/
- http://www.vegagerdin.is/english/
Iceland Network

- Road weather conditions
- Avalanche forecasting and alarming
- Road temperature profiles
- Traffic counting
- Vista Data Vision software
Vegagerð, náttúran og markmið Vegagerðarinnar

Pví fer fjarri að Vegagerðin ráðist í framkvæmdir "sama hvað tautar og fóralar" likt og Bergur Sigurðsson framkvæmdastjóri Landverndar holdur fram í fjölmíðlum í dag.

Pví sökur haggar Vegagerðin sér eins og ríki í ríkinu, þvert á móti. Ákvarðanir um vegalagningu, til dæmis varðandi Dettifossveg, Lyngdalsheiðaveg og Vestfjardarveg um Teigisskóg, eru ekki tekna að gáthuguðu máli eins og stundum mætti ætla af umræðunni.

I öllum þessum tilvikum hefur farið fram þarlegt mat og skoðun á mögulegu veglinum. Vegagerðin leggur fram möguleikana og mælí gjarnan með eintum umfram annan.

Lesa meira til að sjá kort og myndir
Lesa meira

Auglýst útboð og opnarí

Opnun tilboða 22.07.2008. 4 útboð
Vatnsdalsvegur (722): Hvammur - Hringvegur
Grafningsvegur eftir (360), við Úlfþjótsvatn
Vetrarbjónusta Í Eyjafjörð og á Hringvegi(1) að Krossi 2008-201
Landeyjahöfn, hafnar- og vegagerð, eftirlit

Opnun tilboða 15.07.2008. 2 útboð
Heiðarbaut (3357) og Gnúpverjavegur (325)
Landeyjahöfn, hafnar- og vegagerð, eftirlit

Auglýst útboð 14.07.2008. 2 útboð
Vetrarbjónusta, Brjánslaekur-Bilddalur 2008-2011
Hlifðarendavegur í Ölfusi (380)

Fæiri útboð

Vindhráði og vindhviður (métar á sek.)

Vindátt (grádur)
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Summary

• Challenges
  – Telemetry
  – Power
  – Measurement Flexibility
  – Operation and Maintenance
Summary

• Solutions
  – Telemetry
    • Wireless, satellite, 2-way, low power, flexible
  – Power
    • Low power use, no/minimal heating, hybrid
  – Measurement Flexibility
    • Multiple partner standards = cost sharing
  – Operation and Maintenance
    • Reduce long-term power/comm/upgrade costs
Summary

• There are working, off-the-shelf solutions available for diverse rural data-acquisition programs
• Expertise is available to support these systems from multiple sources
• Options of training for DIY
The Companies

• Campbell Scientific Inc.
  – 35 years as a world leader in remote data acquisition hardware and software manufacturer. Over 200 employees. Sold over 100,000 dataloggers into markets ranging from Agriculture, Environmental, Industrial, and Transportation. Often used in research.
The Companies

- GW Scientific
  - Over 20 years experience in Alaska providing full range service of data acquisition from design, programming, metadata data documentation, installation, data collection, data integrity, web posting, and interpretation.
  - CSI integrator.
Thank You

Questions?

www.gwscientific.com
www.campbellsci.com