HydroLynx Lessons Learned in Implementing ALERT2 Upgrades

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HydroLynx ALERT2 System Upgrades

Sacramento County, California
- 2 receivers, 43 transmitter upgrades deployed

Maricopa County, Arizona
- 5 receivers, 2 with transmit capability, 2 deployed
- 15 repeaters, 6 rack, 9 canister, 9 deployed
- 400 transmitter upgrade kits, 278 deployed
- 4 two way ALERT2 flashing roadway light controllers

Ventura County, California
- 2 receivers, 5 repeaters, 1 concentrator deployed
- 2 transmitter upgrades deployed

San Bernardino County, California
- 2 receivers, 2 repeaters deployed
Sacramento County Upgrade

- Sacramento County shares ALERT radio frequencies with 4 other agencies
  - City of Sacramento
  - City of Roseville
  - Placer County
  - National Weather Service, Sacramento

- New ALERT2 frequency added
Maricopa County Upgrade

- ALERT radio frequencies shared with state and other counties
- Using ALERT1 frequencies for ALERT2
- State will now get data from internet exchange instead of upgrading to receive ALERT2 data.
Ventura County Upgrade

- Part of Southern California ALERT2 backbone upgrade funded by California DWR grant
- Receivers and repeaters deployed
- All repeater data in ALERT2
- SHEF data export and import to other agencies
San Bernardino County Upgrade

- Part of Southern California ALERT2 backbone upgrade funded by California DWR grant
- Receivers and repeaters deployed
- All repeater data in ALERT2
- SHEF data export and import to other agencies
Install combined ALERT1 and ALERT2 receiver to support transition to ALERT2.
Use same antenna for ALERT1 and ALERT2.
Add amplified splitter and crystal filters to provide clean on frequency radio signal to receiver.
Replace serial connection to decoder with network connection
ALERT2 Receiver Installations
Receiver Installation Challenges

- Receiver did not get time sync from internet.
  - Use internal network time servers.
- Standard ALERT1 receiver squelch at -113dB allowed continuous noise with preamp.
  - Tested radio squelch at -110dB, -107dB, -104dB
  - Chose -104dB, eliminated noise, no data loss.
- Older decoder received more data than new decoder caused concern for data loss.
  - Reports received by old decoder were always bad reports from other ALERT systems farther away.
ALERT2 Receiver Installation

Sacramento County at Vineyards
ALERT2 Repeater Upgrades

- Chose to upgrade to full ALERT2 repeater not just concentrator.
  - Receive ALERT1 & ALERT2, transmit ALERT2.
  - Three radios required.
- Used splitter for receive antenna.
  - Power preamp and crystal filters for receivers.
- Separate transmit antenna.
- Repeaters have sensor inputs.
  - Rain only and weather station, battery, GPS status.
- Repeater enclosure in canister, rack, NEMA box
  - AC power and solar power.
DC powered preamp with splitter, ready for crystal filters.
Repeater Installation Challenges

- GPS antenna installation required.
- 50 Watt (3 Amp) solar panels required.
- 22 AmpHour battery in canister.
- External battery required for increased endurance.
- Repeater TDMA time frame different from transmitter time frame.
- Ventura and San Bernardino counties hired Water and Earth Technologies.
- Maricopa County was already using TDMA for ALERT1 repeaters.
- Cellular WAN connection added to allow remote programming of repeaters.
Ventura County Sisar repeater with backup.
- Receive antenna 4 split
  - 2 ALERT1 receivers
  - 2 ALERT2 receivers.
- Transmit antenna
  - 2 transmit radios
  - Power divider.
- Repeaters use different TDMA frames.
- Cellular WAN remote programming.
Ventura Repeater Battery and GPS
Sacramento County had HydroLynx upgrade all transmitters to 50386 ALERT2 in fall 2014.
- Deployed 43 transmitters by end of fall 2015.
- Upgrade the remaining 7 transmitters by fall, 2016.

Maricopa County purchased over 350 ALERT2 upgrade kits in spring, 2015.
- Installed upgrades in their shop. 278 ALERT2 transmitters have been deployed.

Ventura County deployed two ALERT2 transmitter upgrades and one concentrator.
- County is applying for more DWR grant money to fund their ALERT2 transmitter upgrades.
5096 ALERT2 Upgrade Installation

Ventura County
Sacramento 5096 transmitters upgraded to 50386 ALERT2 had start up battery failures after first rain storm in December, 2014.

- Batteries were old and undersized. Replaced with new 22 Amp Hour batteries.
- Solar panels were not working well and were replaced with larger panels.
- Transmitter logic and configuration problems prevented units from entering low power mode, draining battery power.
- Solved power problems by end of December.
- Replaced damaged transmitter that had constant standby current drain by end of March.
Sacramento County ALERT2 Batteries Second Year

- 22 amp hour batteries and 10 watt solar panel performance
- All ALERT2 stations performed well over the winter
- Solar charging was reduced during heavy rain and fog periods
- Sites continued transmitting and battery levels recovered when solar recharge resumed.
Battery plots, Oct 2015 to April 2016
After programming change to correct power drain, Sacramento County was missing timed reports from several stations.

In December all stations reported every hour, no reports were missed until battery drained.

When sites not reporting were tested in between hourly reports, transmissions were received.

Changing TDMA time slots affected which stations were missing hourly reports but did not correct it.

Transmitter configurations were tested at HydroLynx and worked perfectly one at a time.

Logical conclusion was there is a system wide error that is causing missing reports.
HydroLynx was unable to remotely monitor incoming ALERT2 data to Sacramento County. A site visit was made to ALERT2 receive site to analyze incoming data feed.

The problem was found immediately. All transmitters were encoding sensor reports in separate application layer packets. This made the packet size greater than the 500 millisecond time slot assigned to the station. Transmitter packets in sequential TDMA time slots were colliding and data was lost.

Firmware update fixed problem by April 1, 2015.
Sacramento County has several level stations with wireless links to multiple sensors.

- Time to measure all levels exceed time to TDMA slot.
- Hourly report delayed until next 2 minute frame time slot.

Possible solutions
- Update wireless links
- Move TDMA time slot to be after time to measure level.
ALERT2 Rainfall Improvements

- ALERT2 rainfall data errors eliminated.
- Double counts in rainfall almost eliminated.
  - Rainfall data analysis of intense December, 2014 storm showed double reports with same time stamp.
  - Tipping buckets from rainfall cannot produce this so mechanical or electrical error assumed.
  - Transmitter firmware updated end of December to filter out tips within same second.
- Could double increment of ALERT1 rainfall data be caused by mechanical or electrical error instead of data lost by radio report collision?
May 14, 2015 ALERT1 vs. ALERT2
May 14, 2015 ALERT1 vs. ALERT2

- ALERT1 data report corrupted by radio collision
Sacramento County ALERT2
Rainfall Second Year

- Linda Creek measured 17.41 inches this year
- The major storms occurred in December, January, and March
Sacramento County ALERT2
Rainfall Second Year

Linda Creek reported each rain gauge tip
ALERT2 Transmitter GPS Challenges

- ALERT2 transmitters require GPS time lock for proper TDMA operation.
  - GPS time lock takes 13 minutes on power up.
  - Hold off transmit until GPS locked.
  - Test mode will override transmit hold off.

- Transmit GPS time status transmit.
  - Monitor remote station GPS status at base station.
  - 0=lock, 2=drift, 3=not locked.

- GPS drift transmits on random slot in frame.
  - HydroLynx transmitters delay timed transmissions by one frame in GPS drift state to prevent collisions with other timed reports.
ALERT2 Transmitter GPS Status
Van Maren station lost GPS lock in March and reported GPS drift mode (2).

Field technician did site visit, repaired problem, restarted transmitter.

First GPS status state is not locked (3) followed by lock (0).
GPS lock very reliable
Occasional drift and automatic recovery without site visit
ALERT2 Transmitter Programming Challenges

- ALERT2 best practices is transmit finished data
- Training required in sensor calibration in transmitter

**ALERT2 MSR vs. GSR**
- MSR is efficient but limits decimal digits.
  - Wind speed in .1 mph requires GSR
  - Battery voltage in .01 Volts requires GSR

**Wind Speed vs. Wind Run**
- ALERT1 wind data transmitted as wind run.
- Training required in wind speed setup.

**ALERT2 radio modulation in Maxon radios**
- Use normal for old, inverted for new SD125E radios.
ALERT2 Base Station Challenges

- ALERT2 station and sensor ID change
  - Use source address for station
  - Sensor ID for station sensor data.

- ALERT2 finished data received.
  - Remove base station calibration of ALERT2 data.

- ALERT2 data not received from neighbors.
  - Exchange data in SHEF format
    - Former ALERT1 data required calibration
    - SHEF data is finished data, no calibration required.
  - Exchange data in XML file format
    - Sacramento County exports two sites in XML report to City of Roseville until ALERT2 receiver purchased.