HOW USING ALERT2™ WILL IMPROVE HIGH WATER DETECTION SYSTEMS

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DISCUSSION TOPICS

- High Water Detection System (HWDS) Overview
- High Sierra ALERT HWDS Solution
- High Sierra/OneRain ALERT2 HWDS Solution
- Initial Systems
- Overland Park Installation
HWDS OVERVIEW

- Hundreds of Low Water Crossings in the US are monitored by High Sierra’s High Water Detection Systems (HWDS). (Other applications: Fog, High Wind, Icy Road / Bridge)

- These HWDS systems use ALERT communications to activate Public Warning Devices (i.e. Flashing Beacons, Gates, Sirens) at Advance Warning Stations.

- HWDS systems warn and protect motorists.

- HWDS provide data to the Base Station Software of the agencies responsible for roads and public safety.

- The Base Station can also send commands to the HWDS systems to get status or override the ON/OFF system state.

- While ALERT has been an effective solution, the advantages ALERT2 offers can significantly improve communication reliability.
HWDS Controller Basics

- A Controller communicates using a simple Command/Response Handshake
- Each Controller has two IDs (for Controller Functionality)
  - Command ID: The controller will act on commands with this ID
  - Status ID: The controller will respond to commands with its ON/OFF status using its Status ID
  - The Command and Status IDs are configured in the Controller’s “Command” sensor
- Master Controllers and Base Stations send Commands to Controllers using their Command ID
- Remotes never send commands, only ON/OFF responses to commands.
## I/O Points

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Add</th>
<th>Multi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery</td>
<td>Battery</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Pressure Tx</td>
<td>Analog 3</td>
<td>0.0</td>
<td>0.004094</td>
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<tr>
<td>GPS Status</td>
<td>GPS_Status</td>
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<td>1.0</td>
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<tr>
<td>Command</td>
<td>Remote</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

## Configure I/O Points

- **Name:** Remote
- **Type:** Command
- **Master:**
- **Command ID:** 1000
- **Status ID:** 1001
- **Group ID:** 1002

### Local Test Control

- Out1: Turn On, Turn Off
- Out2: Turn On, Turn Off
- Out3: Turn On, Turn Off
- Out4: Turn On, Turn Off

- Repeater OFF
- Pass All

- Update Sensor
MAIN HWDS COMPONENTS

Base Station

We’re OFF

Turn OFF

I’m OFF

VHF Transceiver

Master Controller Site
Rain & PT

Flood Level

Remote Controller Site

VHF Transceiver

Roadway Flooded
Problem: Roadway has 2 waterways that may flood.
Solution: A Master is placed at each waterway to monitor water level.

FLOOD WARNING WITH MULTIPLE FLOOD SOURCES
Example: 1 Master with 8 Remotes

- M
- R1
- R2
- R3
- R4
- R5
- R6
- R7
- R8
Example: Maximum Capacity of a Master - 32 Remotes

Channel 1 (DO1)  Channel 2 (DO2)  Channel 3 (DO3)  Channel 4 (DO4)
Example: 1 Master with 8 Remotes, etc
**Desired Architecture**
Leverage High Sierra’s existing HWDS solution in an ALERT2 environment.

**Challenges**
- 2-Way ALERT2 is not yet defined (Proposals before TWG currently)
- ALERT2 does not have an efficient way of sending commands and status responses

**Solution**
- Leverage ALERT2 protocol to send binary commands/status as concentrated ALERT
- All other sensor data is still sent as ALERT2

**Advantages**
- Uses HSE’s HWDS protocol that is tried and proven with over 500 systems in service
- Maintains a typical slot width requirement of 0.5 second
  - Typical Sensors: Battery, GPS, PT, Controller, Rain
- Maintains the flexibility of the architecture to handle both simple and complex systems
Reuse Existing Equipment

- Determine what existing equipment can be used and what needs to be replaced or added

TDMA Plan

- Determine Frame Length (acceptable latency and network size)
- Slot Size – current command messages work in 500 mS

Frequencies

- Determine how many frequencies are needed for the network

Power Requirements

- Determine if existing solar and battery is sufficient
ALERT2 HWDS 2-WAY ARCHITECTURE

Transmit Path

Receive Path

HSE
HWDS Controller

Decoder

Ritron
Radio

Encoder
TDMA Timing

1. The master will send a single multicast HWDS command directed to all its remotes at its time slot. This multicast will be a single Group ID that is assigned to the remotes and known by the master. This results in a simultaneous activation of all remotes.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

3. As a general rule, a remote master (and its remotes) will have half the TDMA frame period of its controlling master, effectively giving it two slots.
   1. In its first time slot it will send the command to its remotes and wait for their response. These remotes will have time slots assigned prior to their master's next time slot.
   2. At the remote master's next time slot it will send its response to the controlling master, in time for the controlling master’s next time slot.

4. Retries
   1. Each retry will delay a controlling master from sending its status by one frame period.
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single Group ID that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Group ID: 5000**

Status: R1 is ON
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.
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2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Status:** R3 is ON
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Group ID: 5000**

Status: R4 is ON
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Status:** R5 is ON
ALERT2 HWDS OPERATION

1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

Group ID: 5000

No Resp from R6
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Status:** R7 is ON
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Group ID: 5000**

Status: R8 is ON
ALERT2 HWDS OPERATION

1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single **Group ID** that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.

**Group ID: 5000**

Status: R6 is ON
1. The master will send a single multicast command directed to all its remotes at its time slot. This multicast will be a single Group ID that is assigned to the remotes and known by the master.

2. The master will then wait up to its next TDMA slot for responses from all remotes, which reply in their designated time slots.
Example of Remote Master TDMA Timing

Remote Masters and their Remotes have half the TDMA frame period, 2 cycles within the controlling Master’s 1 cycle.
CAPACITY OF HWDS ON AN ALERT2 NETWORK

How many HWDS systems can fit on a single frequency?

- Slot Width
- Frame Period
- Number of Remotes per Master

Example: Typical configuration in Bexar Co, Texas is 1 Master and 2 Remotes per system.

- 60 Second Frame Period and half second slot width
- \[(120 \text{ Slots}) / (3 \text{ units per system}) \Rightarrow 40 \text{ Systems/Freq}\]
INITIAL ALERT2 HWDS SYSTEMS

- Overland Park, KS on April 18, 2017
  - Scott Bores (OneRain) and John Keating (City of OP)
  - Installed Merriam system of 1 Master and 5 Remotes
  - Master Sensors: Command, GPS, Battery, PT (analog), Rain
  - Remote Sensors: Command, GPS, Battery, Beacon Current

- Bexar County, TX – June 2017
  - System of 1 Master, 2 Remotes and Base Transceiver
  - Installed and maintained by HSE Texas Field Crew
POWER REQUIREMENTS

- Overland Park’s Merriam System is currently using a 50W solar panel and a single 100AHr battery
  - 24 dark days, beacons OFF
  - 6 dark days, beacons ON

- Example of greater capacity - 85W solar panel and two 100AHr batteries
  - 47 dark days, beacons OFF
  - 12 dark days, beacons ON
  - HSE works with the customer to determine the best solution
# MESSAGE LENGTH

## Slot requirement calcs for OP 2Way A2 Controller

### Slot Requirement for master

<table>
<thead>
<tr>
<th>Concentration</th>
<th># Bytes</th>
<th>GSR</th>
<th># Bytes</th>
<th>Precip w 1 tips</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWDS Command</td>
<td>8</td>
<td>GPS</td>
<td>4</td>
<td>Precip 1</td>
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<tr>
<td></td>
<td></td>
<td>Battery</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>PT</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

**Total Bytes:**

| 19 | 29 | 16 | 64 | 464 msec |

### Slot Requirement for remote

<table>
<thead>
<tr>
<th>Concentration</th>
<th>GSR</th>
<th># Bytes</th>
<th>GSR</th>
<th># Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWDS Status</td>
<td>GPS</td>
<td>4</td>
<td>BeaconCu</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Battery</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Bytes:**

| 15 | 29 | 44 | 344 msec |

**Master:** 464 msec  
**Remotes:** 344 msec
OVERLAND PARK BETA SYSTEM

Merriam HWDS System
1 Master and 5 Remotes

- Replace ALERT L-Panel Backplane with ALERT2 L-Panel Backplane
- Add GPS cable and Antenna
- Additional battery/solar - postponed, running on existing 50W panel and single 100AH battery
OVERLAND PARK HWDS SYSTEM INSTALLATION

Before: Old “Green Box” panel inside cabinet
After: New ALERT2 HWDS panel inside cabinet
OVERLAND PARK HWDS SYSTEM INSTALLATION

Master Site with PT and Rain
OVERLAND PARK HWDS SYSTEM INSTALLATION

Master Site with PT and Rain
OVERLAND PARK HWDS SYSTEM INSTALLATION

Two Remotes with Beacon Flashers
OVERLAND PARK HWDS SYSTEM INSTALLATION

Two Remotes with Beacon Flashers
OVERLAND PARK HWDS SYSTEM INSTALLATION

Third Remote
OVERLAND PARK HWDS SYSTEM INSTALLATION

Fourth Remote
Fifth Remote
OVERLAND PARK HWDS SYSTEM INSTALLATION

GPS Antenna Cone
PT Pressure Test
Storm Watch (Overland Park): Master with High Threshold Event

Graph

Master Status 63 = All ON
Water Level
Flood Level
Storm Watch (Overland Park): Remote Site High Threshold Event

Beacon at 1.7mA

Site Status = I’m ON
Comment from Dan Hurley, City of Overland Park

From an operator's perspective there are two big benefits. The first is the improved reliability of the reporting from each site in the Merriam system. Although a lot of our radio path problems we had previous to the Alert2 installation had to do with our system design, the increased gain from Alert2 certainly helped things. The second is the confidence level we have in the system. With the previous Alert flasher system we had perpetual battle with noise and data contention with all the ALOHA traffic going on. Knowing that the master and each remote have their own time slot has had a genuine positive impact in our confidence level with the data that we are receiving. I would bet that our experience in improved data quality with other Alert2 applications in our system will validate this higher level of confidence in our new Alert2 flasher system.
TWO-WAY ALERT2 - PROPOSALS

- **Repeaters**
  - Pass List
  - Configure Frame and Slot Size

- **Set, Get and Tell**
  - Tell – Tell a sensor value (current mode)
  - Set – Set a sensor value
  - Get – Get a sensor value

- **Vendor Type (ID registered with SAMS)**
  - Vendor specific (non sensor centric)
  - Examples – Command, Configuration, TDMA parameters, slope/offset, enable / disable a sensor
  - Recommendation that Vendor specific implementations be posted publicly