

Wireless Sensor Networks for Real-Time Environmental and Soil Monitoring



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Butler's Orchard
Germantown, Maryland

<https://www.youtube.com/watch?v=Vt1kG6BIIjc>

Introduction

- Partnership with University of Maryland
 - Real-time information - environmental and soil conditions
 - More efficient use of resources
 - Water, fertilizer, time
 - Improved yield and quality
 - Sustainable production - economic and environmental

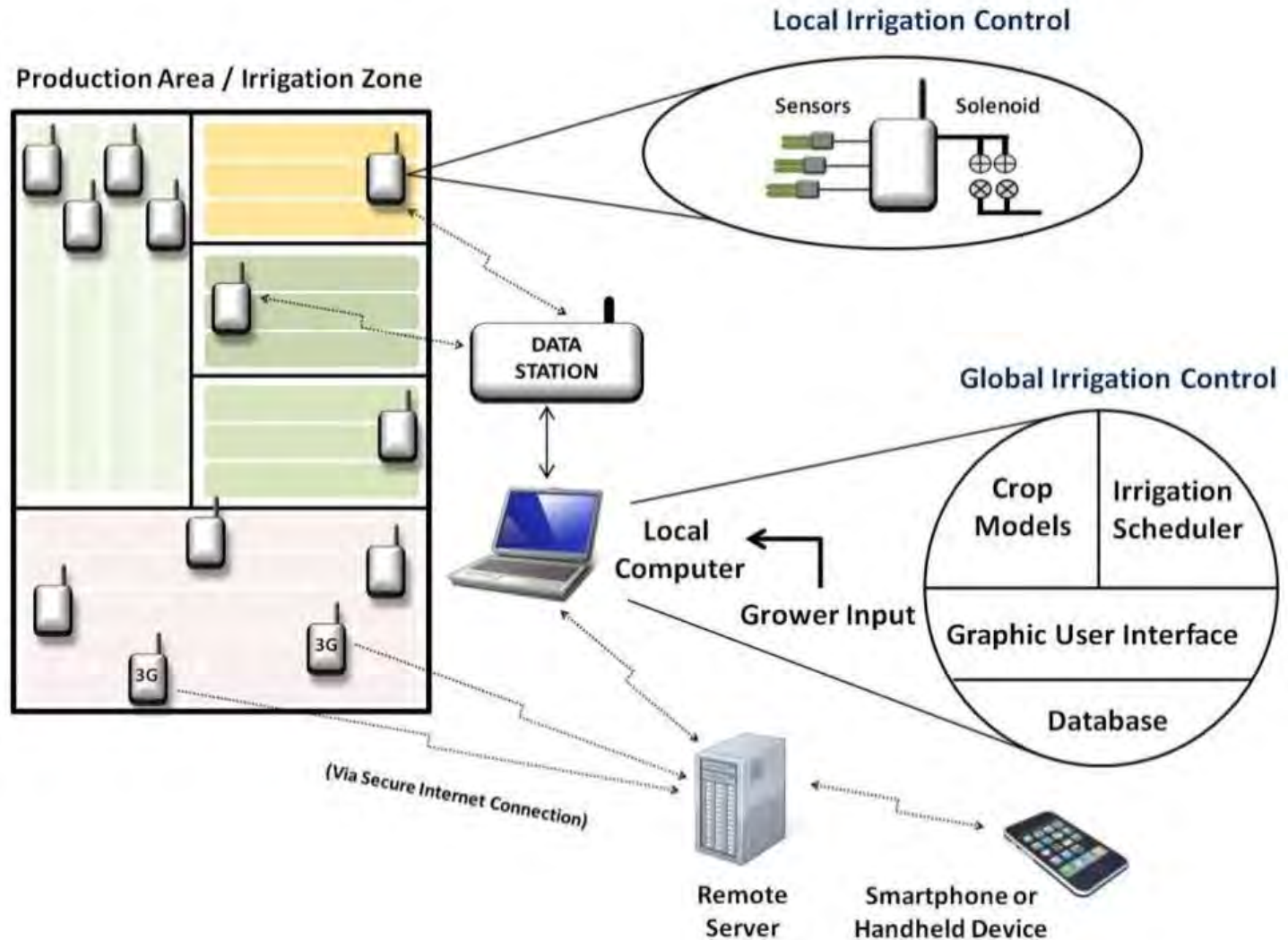
Objectives

Use of wireless sensor networks for:


1. Real-time environmental monitoring
2. Frost monitoring during early spring
3. Irrigation and nutrient management

➤ Better decision making!

Sensor Networks



Sensor Network at Butler's Orchard




www.mayimllc.com

Butler's Orchard Sensorweb

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Current Weather
?:
0.0
umol/(m²*s)

Other Sites ▶



Mouse over location for details (arrows show recent trends). Double click for more details.?











	100.0		70.0		25.0		10.0		Not in other ranges
	70.0		25.0		10.0		0.0		

Image Measurements:?

Average ▼ Battery Life ▼ Update Map

Environmental Monitoring

**DS-2 Sonic
Anemometer**
Wind speed and direction

VP-3
Temp, RH, VPD



Pyranometer
Solar Radiation

QSO-S PAR
PAR (visible light)

**ECRN-100 Rain
gauge**
Precipitation

**Em50R data
logger**

Weather station at Butler's Orchard

Real-time Weather Data

Data View Page

Navigation


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Current Weather?

:
 0.0
 $\text{umol}/(\text{m}^2\text{s})$

Other Sites ▶

Data View ?



Click on a location in the image above or click on a location name below to view nodes and growing tools at that location. Double click locations in the image to see details.
[Show All Locations](#)

Frost Nodes ▶

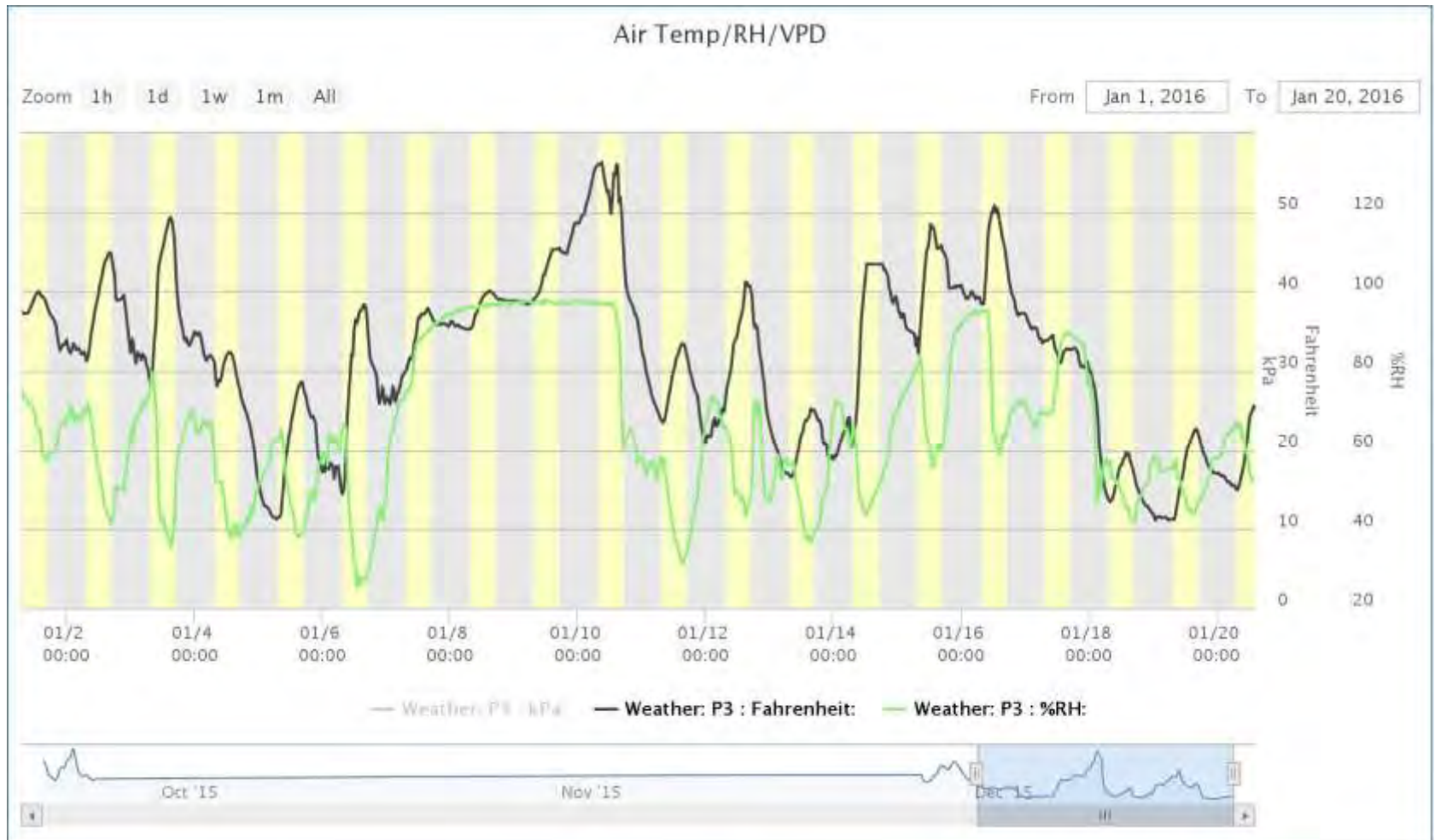
- GCI_1 ▶
- GCI_2 ▶
- GCI_3 ▶
- GCI_4 ▶
- SCI_1 ▶
- SCI_2 ▶
- SCI_3 ▶
- SCI_4 ▶

Weather 2 ▼

Weather	Wed Jan/20/16 14:20 68.0% battery	$117.188\text{W}/\text{m}^2$	$234.375\text{umol}/(\text{m}^2\text{s})$	0.24kPa 25.34Fahrenheit 51.606%RH	213.0Degrees 1.924mph average 4.698mph gusting	0.0inch
Daily Light Integral	Wed Jan/20/16 14:06 DLI	$8.62\text{ mol}/(\text{m}^2\text{d})$				
GDD_1	Wed Jan/20/16 14:06 GDD	-16.45 GDD				
Rainfall Last 24 hours	Wed Jan/20/16 14:06 Accumulator Tool	0.0 inch				
Rainfall Today	Wed Jan/20/16 14:06 Accumulator Tool	0.0 inch				

Weather Data

Air Temp. and RH data



Frost Monitoring

- Current frost prediction tool - Sky-Bit (Satellite data)
- Air temperature (AT) is not a reliable predictor frost events
- Canopy temperature (CT) – sensed by leaves and flower buds
- Radiation frost: $CT < AT$ on clear and calm nights



- 2 precision thermistors
- Mimic plant leaf and flower bud
- Measurement Range:
-50 to 70 °C
- Accuracy:
 ± 0.1 to ± 0.4 °C

SF-110 Radiation Frost Sensor
(Apogee Instruments, Logan, UT)

SF-110 Radiation Frost Sensors

Air Temp vs. Canopy Temp



Alerts on Sensorweb

Example of an alert setup based on Air Temp.



Butler's Orchard Sensorweb

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Alert Settings

Alert Active: ? Name:

How often should alerts be checked: ?

Fixed interval (every x minutes)

At a specific time (ex. 16:30)

Please enter the time or frequency to monitor alerts (based on options above): ?


Set item for alerts to monitor:

Set alert setpoint value to ? , and send alert if value goes the setpoint value.

Notification type *: ? to:

Current Weather

?:

 0.0
umol/(m²*s)

[Other Sites](#) ▶

* You are responsible for any text message or other charges resulting from alerts generated by this system.
This system makes no guarantee about the alert being sent out properly.

Irrigation and Nutrient Management

- Production block: 450 ft. by 120 ft. wide (32 matted rows)
- 8 nodes distributed throughout the block



Nodes and Sensors

- 10HS (Soil moisture content)
- GS-3 (Soil moisture content, temperature and electrical conductivity)
- Badger flow meter (Irrigation application volumes)
- Em50R (monitoring) and nR5-DC prototype nodes (Irrigation control capable)

Sensor Installation



10HS



GS-3



Solenoid valve

Badger
Flowmeter




nR5-DC node

Sensor-controlled Irrigation

Automatic sensor-controlled irrigation scheduling via Sensorweb

Irrigation Scheduler



Select Irrigation Node/Group: [Configure Irrigation Groups ?](#)

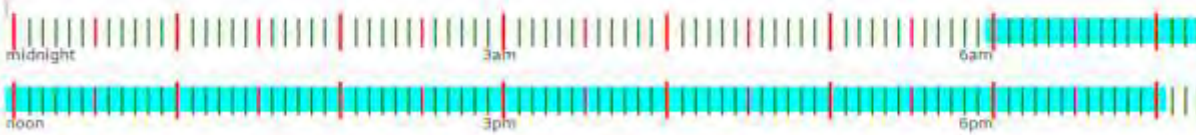
Select Irrigation Control Source:

Growing tool to use: Output to use:

Low Setpoint:

Pulse Type: [Edit pulse types here](#)

Click on start and end point to create (or delete) schedule below: [Click here to view all schedules](#)



Add an irrigation event at a specific time that will ALWAYS occur (set time to --- to disable): [?](#)

Time (hour/minute): Length of irrigation event: minutes (must be under 300 minutes).

Irrigation set up for the sensor-controlled block at Butler's Orchard

Acknowledgments



This project is funded by a grant from the Walmart Foundation and administered by the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability