

MCerberus®

The HVAC Monitoring "WatchDOG" System

Ron Roth, Ph.D.
RT Automation

RT Automation: We make automation simple™

Central HVAC Operation and Status

- Homeowners do not know the operating state of their HVAC systems.
- Most individuals WAIT until their HVAC system has an issue before calling for service.



MCerberus® HVAC Monitoring System

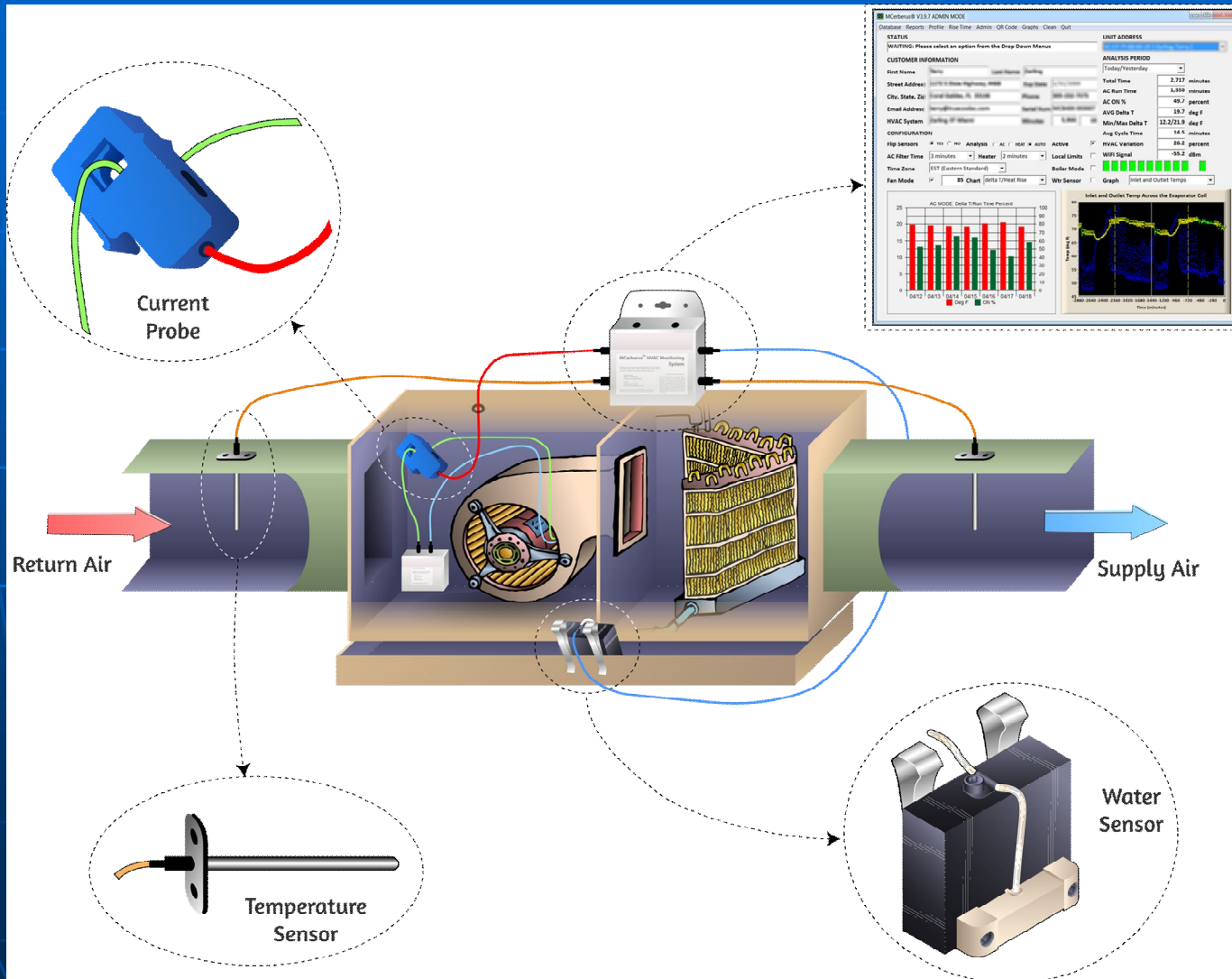
- Continuous monitoring of Central HVAC Units in Residential and Businesses
- Low Hardware and Installation Cost
- Determines real-time operational state of equipment via our Backoffice Software Solution
- Net Savings due to lower energy bills as well as minimizing repair costs



MCerberus® Summary

- The **PRODUCT HARDWARE** may be installed on any Central HVAC unit
- The **PRODUCT HARDWARE** Unit takes measurements every 60 seconds and transmits the data to our Cloud based MySQL database
- The **BACK END OFFICE SOFTWARE** analyzes the data and determines the current state of the equipment
 - The **SOFTWARE** is executed by the HVAC Contractor and/or Homeowner
 - The data is evaluated with respect to established “rules” which determine the **OPERATIONAL STATE State** of the HVAC unit
 - The **SOFTWARE** includes automated report capability allowing the HVAC Contractor to manage multiple installations

HVAC Monitoring Schematic



HARDWARE INSTALLATION



- Configure WiFi
- Install Inlet and Outlet Temp Sensor
- Install Water Sensor
- Install Current Clamp on Air Handler Power
- Connect 120VAC Power (85 – 305VAC)

Backend Office Software Solution

mCerberus V2.2.15 ADMIN MODE

Database Reports Profile Rise Time Admin Clean Quit

STATUS
WAITING: Please select an option from the Drop Down Menus

CUSTOMER INFORMATION

| | | | |
|------------------|-----------------------------|-----------|-----------|
| First Name | John | Last Name | Homeowner |
| Street Address | 1234 Homeowner Address | | |
| City, State, Zip | San Antonio, TX 78216 | | |
| Email Address | homeowner@yahoo.com | | |
| HVAC System | Lennox Main Unit 5 Ton Unit | | |
| Exp Date | 08/19/2036 | | |
| Phone | 210-555-1212 | | |
| Acct # | RR123456 | | |
| MINUTES | 498 | 1 | |

CONFIGURATION

Flip Sensors: YES NO Analysis: AC HEATER

AC Filter Time: 5 minutes Heater: 2 minutes

Time Zone: CST (Central Standard) Active:

Fan Mode: Chart: delta T/leaf Rise

HARDWARE ADDRESS
8:FE:34:D4:0A:77 | Homeowner, John

ANALYSIS PERIOD
One Week

| | | |
|---------------|-------|---------|
| Total Time | 9,964 | minutes |
| AC Run Time | 2,720 | minutes |
| AC ON % | 27.3 | percent |
| AVG Delta T | 21.9 | deg F |
| Min Delta T | 17.0 | deg F |
| Max Delta T | 26.4 | deg F |
| ON/OFF Events | 343 | |
| WiFi Signal | -83.4 | dBm |

SUMMARY

STATE: [Green Bar]

Graph: Inlet and Outlet Temps

Delta T/AC Run Time Summary

| Date | Delta T Mean (deg F) | AC ON Percentage |
|-------|----------------------|------------------|
| 04/23 | 24 | 40 |
| 04/24 | 22 | 20 |
| 04/25 | 21 | 40 |
| 04/26 | 23 | 50 |
| 04/27 | 23 | 30 |
| 04/28 | 20 | 40 |
| 04/29 | 21 | 50 |

Inlet and Outlet Temp Across the Evaporator Coil

Temp (deg F) vs Time (minutes)

O/S: Windows and MAC
Windows emulator mode

AC and Heat Analysis Modes

Computes delta T, Run Time,
and ON/OFF Cycles over the
Selected Analysis Period

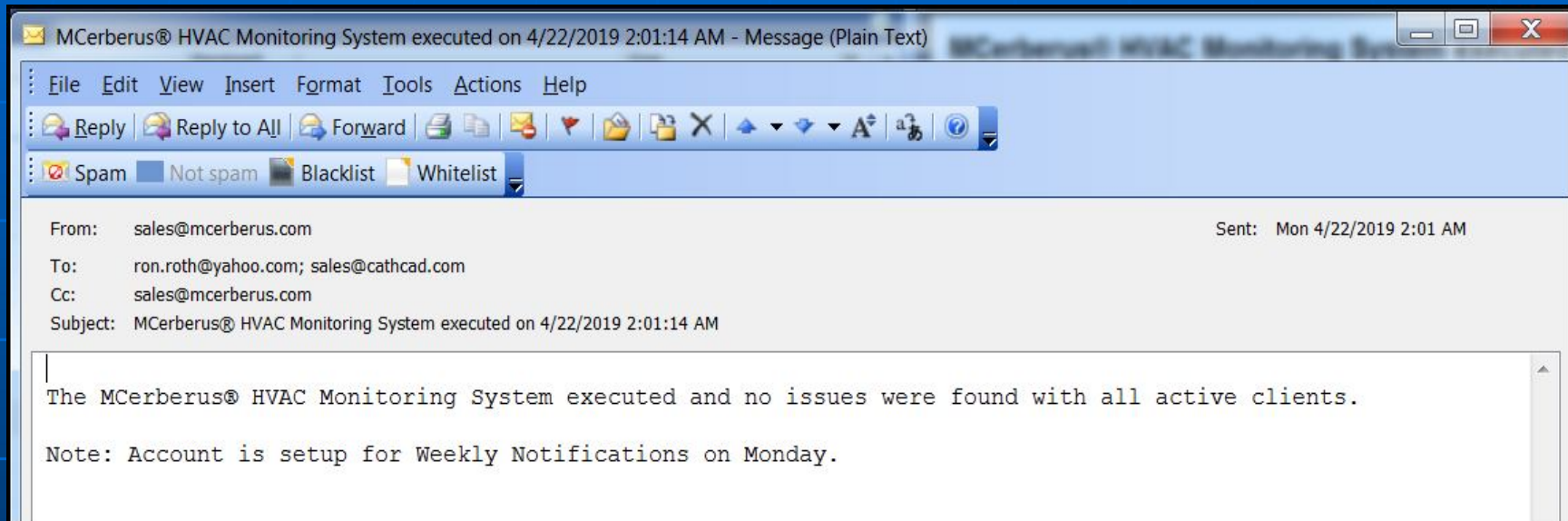
Monitoring Status Indicators

Water Sensor detection

Contractor Mode: Generates
an Excel report that identifies
units with issues

Designed for the HVAC
Contractor for managing 10,
100, or even 1,000+ units

Daily Server Agent Notification



Automatic Report Generation

The SOFTWARE provides the capability to the HVAC Contractor to generate and export a Summary report in Microsoft Excel.

| CUSTOMER INFORMATION | | | | | | | NOTE: ANALYSIS SUMMARY | | | | | | | | | |
|----------------------|---|------------------|--------------|----------------|---------------------------------|-------------------|------------------------|-------------------|-----------|--------------------|---------------------|---------------------|--------------|---------------|------------------|-----------|
| CUSTOMER NAME | STREET ADDRESS | HVAC DESCRIPTION | PHONE NUMBER | ACCOUNT NUMBER | EMAIL ADDRESS | AC STATUS SUMMARY | TOTAL TIME (MIN) | AC RUN TIME (MIN) | AC ON (%) | AC DELTA T (DEG F) | MIN DELTA T (DEG F) | MAX DELTA T (DEG F) | DELTA T HIGH | DELTA T (LOW) | AC RUNS TOO MUCH | AC TO LIT |
| Homeowner, Joe 1 | 1234 Anywhere Str, Mailbox 1 San Antonio, TX 78216 | HVAC Description | 210-555-1212 | | johnhomeowner1@emailaddress.com | FAILED | 9,779 | 1,575 | 16.1 | 8.0 | 4.9 | 16.9 | PASSED | FAILED | PASSED | PAS |
| Homeowner, Joe 0 | 1234 Anywhere Str, Mailbox 0 San Antonio, TX 78216 | HVAC Description | 210-555-1212 | | johnhomeowner0@emailaddress.com | PASSED | 9,781 | 475 | 4.9 | 14.2 | 9.1 | 18.4 | PASSED | PASSED | PASSED | PAS |
| Homeowner, Joe 3 | 1234 Anywhere Str, Mailbox 3 San Antonio, TX 78250 | HVAC Description | 210-555-1212 | XYZ1234 | johnhomeowner3@emailaddress.com | PASSED | 9,797 | 1,268 | 12.9 | 11.3 | 5.4 | 17.9 | PASSED | PASSED | PASSED | PAS |
| Homeowner, Joe 4 | 1234 Anywhere Str, Mailbox 4 San Antonio, TX 78216 | HVAC Description | 210-555-1212 | RR123456 | johnhomeowner4@emailaddress.com | PASSED | 9,824 | 1,537 | 15.6 | 19.8 | 17.0 | 25.0 | PASSED | PASSED | PASSED | PAS |
| Homeowner, Joe 5 | 1234 Anywhere Str, Mailbox 5 Bulverde, TX 78163 | HVAC Description | 210-555-1212 | | johnhomeowner5@emailaddress.com | PASSED | 9,750 | 1,021 | 10.5 | 18.3 | 14.3 | 21.9 | PASSED | PASSED | PASSED | PAS |

Mobile Application (iOS and Android)

App Store Preview This app is only available on the App Store for iOS devices.

MCerberus® HVAC Monitoring 4+

The Equipment WatchDOG

Ron Roth

★★★★★ 5.0, 1 Rating

Free

iPhone Screenshots

MCerberus® HVAC Monitor

- MCB400 Unit MAC ID: SC:CF:7F:88:8E:2E
- MCB400 Unit MAC ID: DC:4F:22:21:58:2F
- MCB400 Unit MAC ID: SC:CF:7F:88:8A:08

Submit

CONTACT INFORMATION
RT Automation
14111 Bluff Grove Drive
San Antonio, TX 78216
www.mHVACmonitor.com

HVAC Monitoring Menu

MAC ID: SC:CF:7F:88:8A:08

Location: Lennox 3T Bedroom

WiFi Strength: -61.27

Furnace Mode: Furnace AC

- Delta T Summary
- Daily Run Time Summary
- ON/OFF Cycle Summary
- Cycle Run Time Summary
- Operating Summary
- Operating Overall Summary

Delta T Summary

Furnace Mode
Delta T (°F)

| Date | Delta T (°F) |
|-------|--------------|
| 12/22 | 41.84 |
| 12/23 | 40.27 |
| 12/24 | 41.15 |
| 12/25 | 40.95 |
| 12/26 | 40.27 |
| 12/27 | 41.54 |
| 12/28 | 41.95 |

Daily Run Time Summary

Furnace Mode
Daily Run Time Percent

| Date | Daily Run Time Percent |
|-------|------------------------|
| 12/22 | 10.8 |
| 12/23 | 14.8 |
| 12/24 | 10.8 |
| 12/25 | 14.1 |
| 12/26 | 21.1 |
| 12/27 | 20.1 |
| 12/28 | 10.8 |

PRODUCT CASE STUDY: GOOD HVAC SYSTEM

mCerberus® V2.4.0 ADMIN MODE

Database Reports Profile Rise Time Admin Clean Quit

STATUS
WAITING: Please select an option from the Drop Down Menus

HARDWARE ADDRESS
5C:CF:7F:00:75:61 [Homeowner, Jame

CUSTOMER INFORMATION

First Name: James Last Name: Homeowner
Street Address: 1234 Anywhere Street Exp Date: 01/31/2099
City, State, Zip: San Antonio, TX Phone: 210-380-9890
Email Address: sales@cathcad.com Acct #: XYZ12345
HVAC System: ST Lennox System MINUTES: 607 1

ANALYSIS PERIOD
One Week

Summary Statistics:

| | | |
|---------------|-------|---------|
| Total Time | 9,823 | minutes |
| AC Run Time | 1,740 | minutes |
| AC ON % | 17.7 | percent |
| AVG Delta T | 20.0 | deg F |
| Min Delta T | 18.3 | deg F |
| Max Delta T | 22.7 | deg F |
| ON/OFF Events | 322 | |
| WIFI Signal | -66.3 | dBm |

CONFIGURATION

Flip Sensors: YES NO Analysis: AC HEATER
AC Filter Time: 10 minutes Heater: 2 minutes
Time Zone: CST (Central Standard) Active:
Fan Mode: Chart: delta T/Heat Rise

SUMMARY

STATE

Graph: Inlet and Outlet Temps

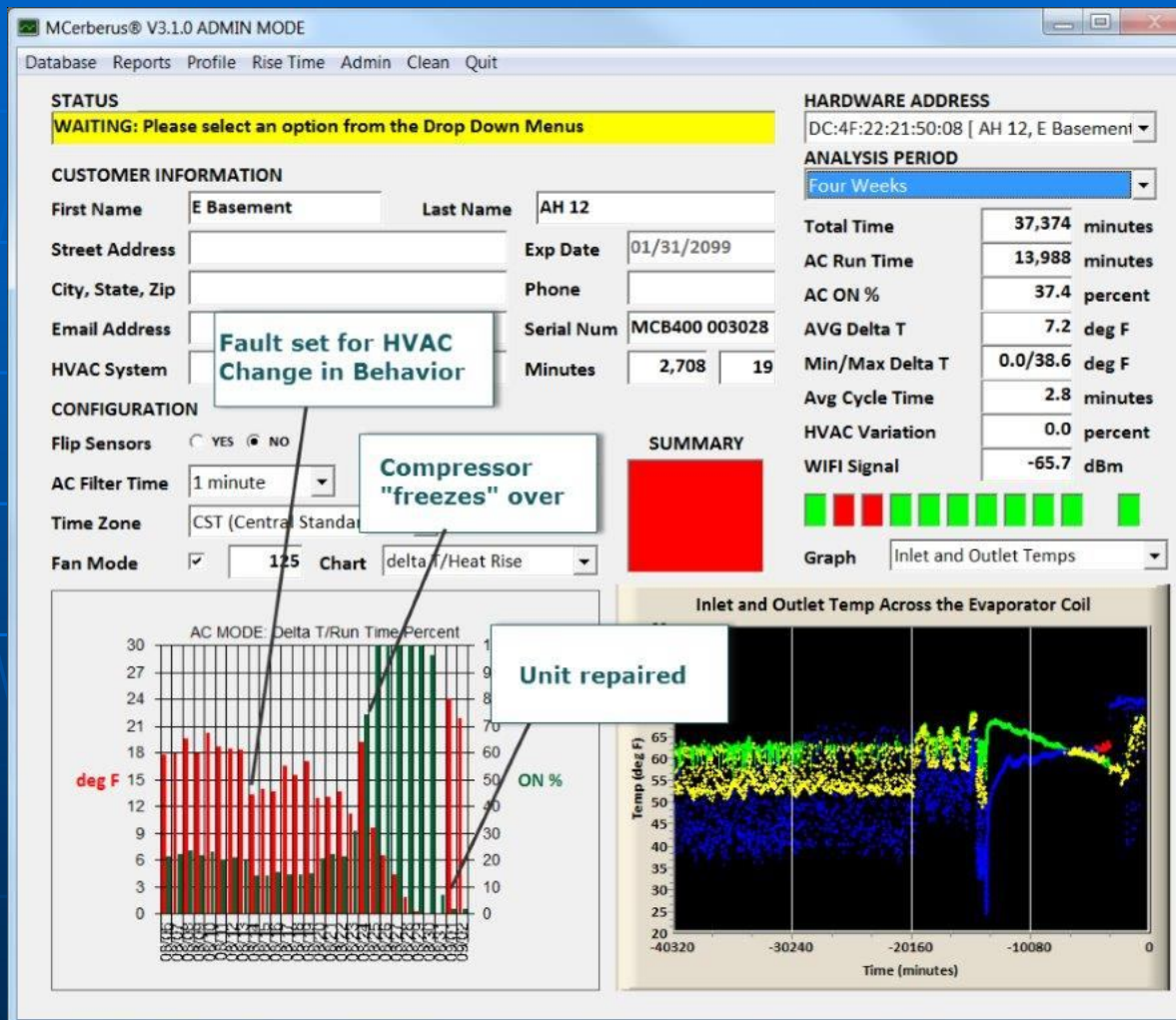
Delta T/AC Run Time Summary

| Date | Delta T Mean (deg F) | ACON Percentage |
|-------|----------------------|-----------------|
| 05/19 | 20 | 20 |
| 05/20 | 20 | 20 |
| 05/21 | 20 | 20 |
| 05/22 | 18 | 10 |
| 05/23 | 20 | 20 |
| 05/24 | 20 | 20 |
| 05/25 | 20 | 20 |

Inlet and Outlet Temp Across the Evaporator Coil

| Time (minutes) | Inlet Temp (deg F) | Outlet Temp (deg F) |
|----------------|--------------------|---------------------|
| -10080 | 75 | 55 |
| -8640 | 75 | 55 |
| -7200 | 75 | 55 |
| -5760 | 75 | 55 |
| -4320 | 75 | 55 |
| -2880 | 75 | 55 |
| -1440 | 75 | 55 |
| 0 | 75 | 55 |

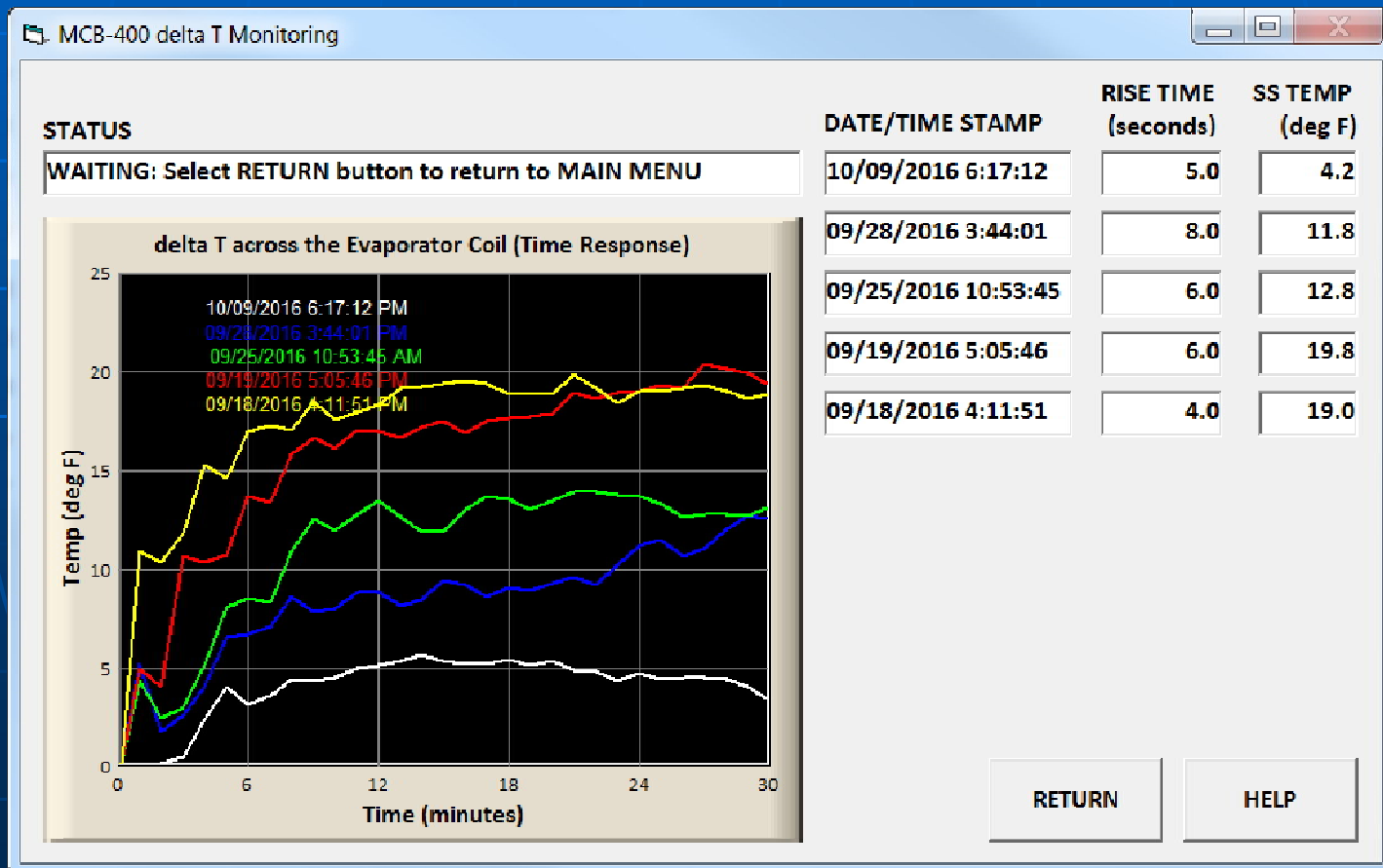
Compressor Freeze-over Event



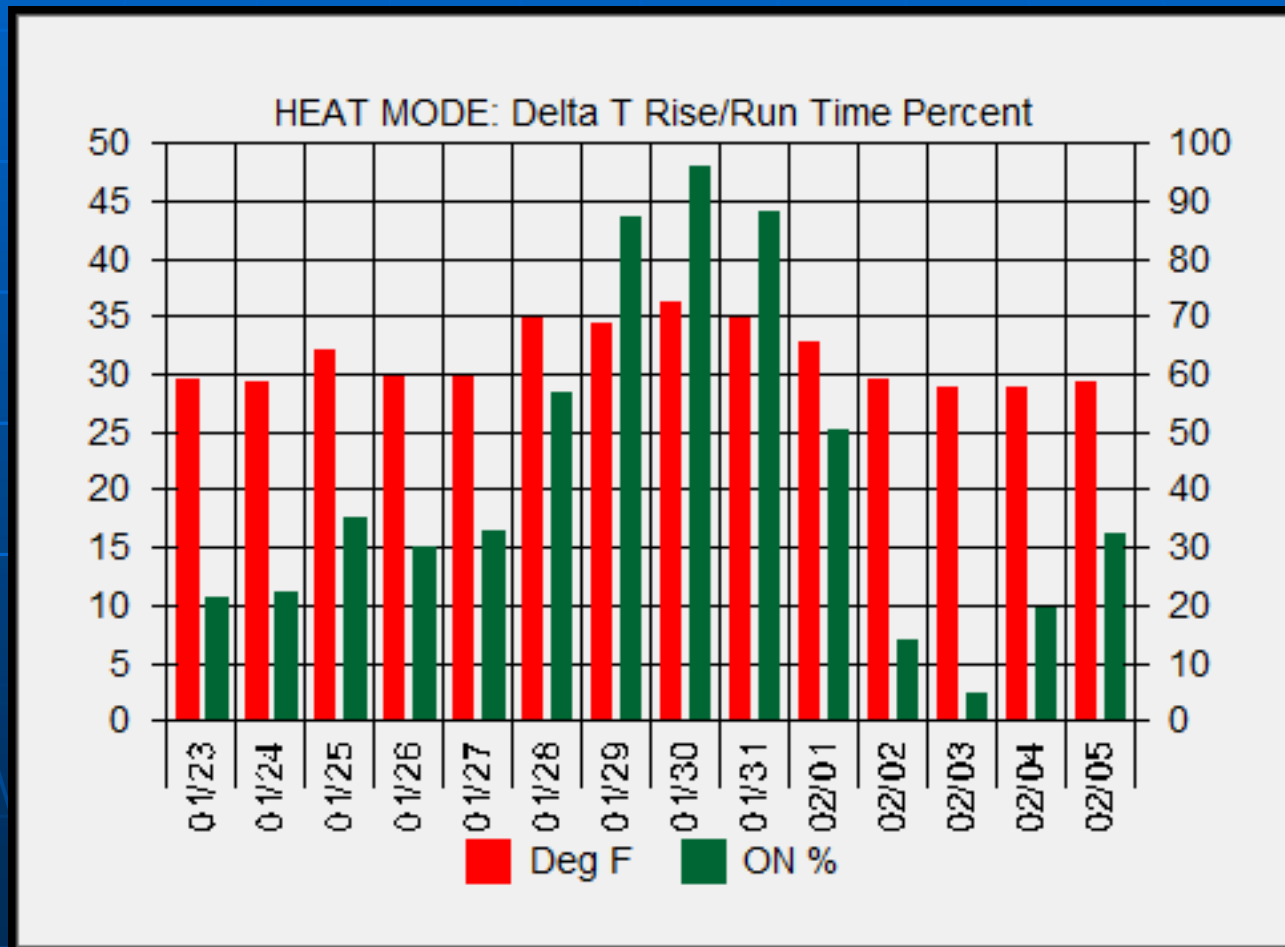
System detected compressor issues eleven days before compressor freeze-over event occurred

PRODUCT CASE STUDY: Refrigerant Leak Detected

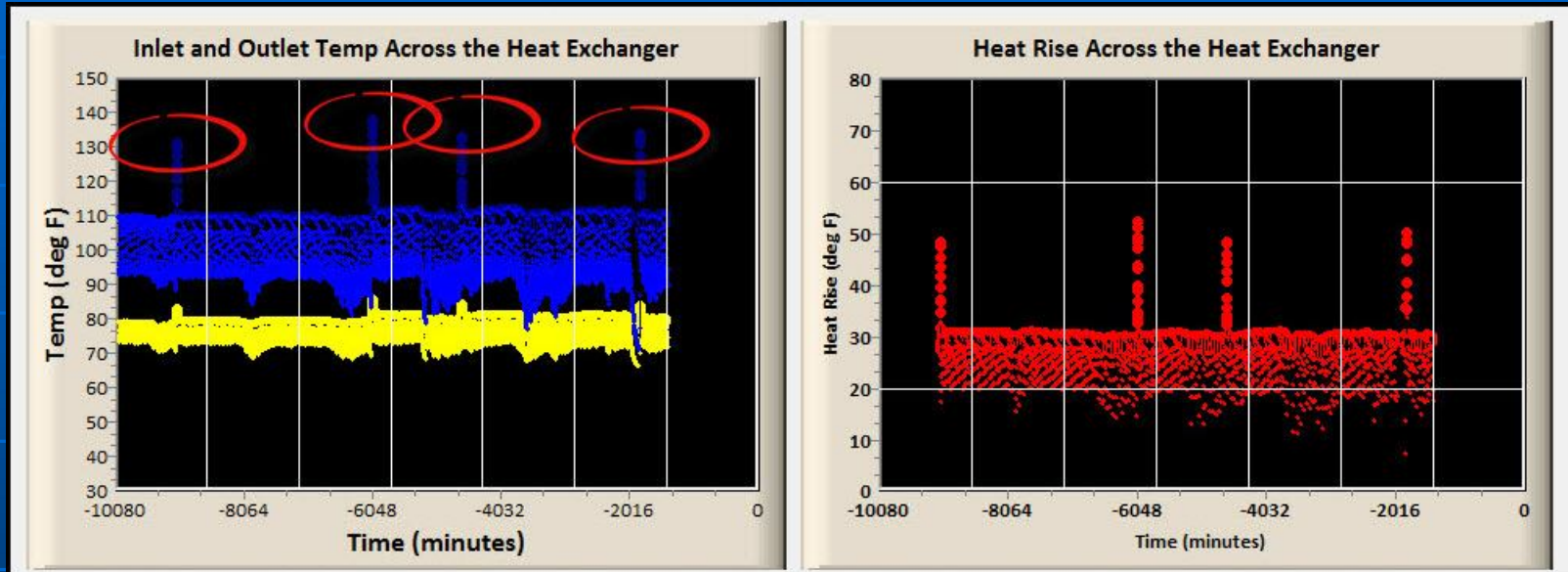
- SOFTWARE identified Refrigerant Leak within one week of its occurrence
- Homeowner did not notice issue until three weeks
- Our SOFTWARE moved the detection date FORWARD by two weeks



2019 Polar Vortex (Iowa Installation)



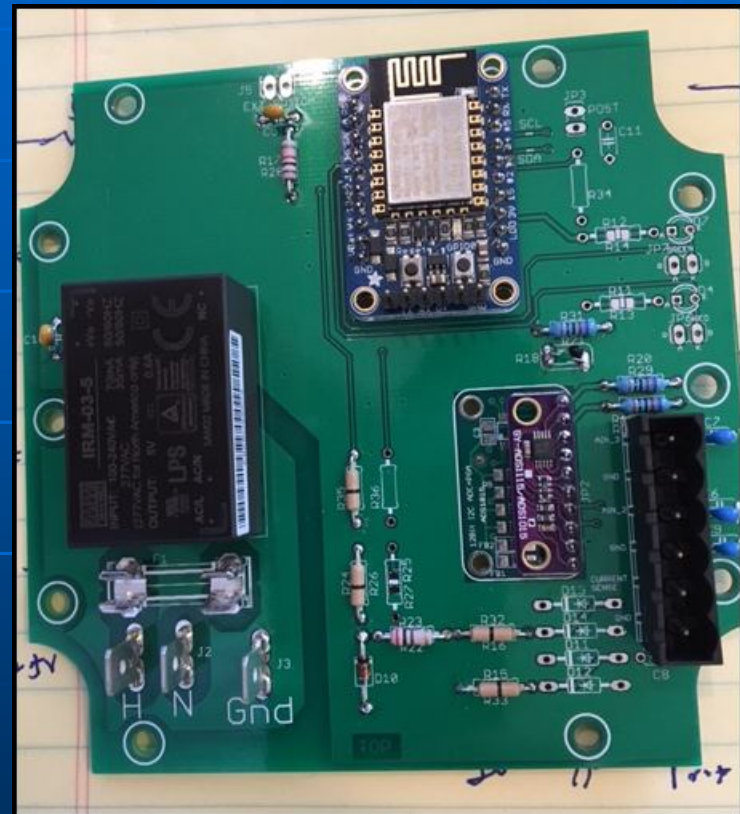
PRODUCT CASE STUDY: Bad Motor Starter Capacitor



- Residential Installation of PRODUCT in Iowa (Furnace)
- PRODUCT identified where the FAN would not turn on
- Bad motor starter capacitor identified and replaced

Product Pricing/Availability

- Hardware Pricing
 - Single Units: \$295/each
 - 100X: \$250/each
- No charge for hosting/storage of data for the first five years



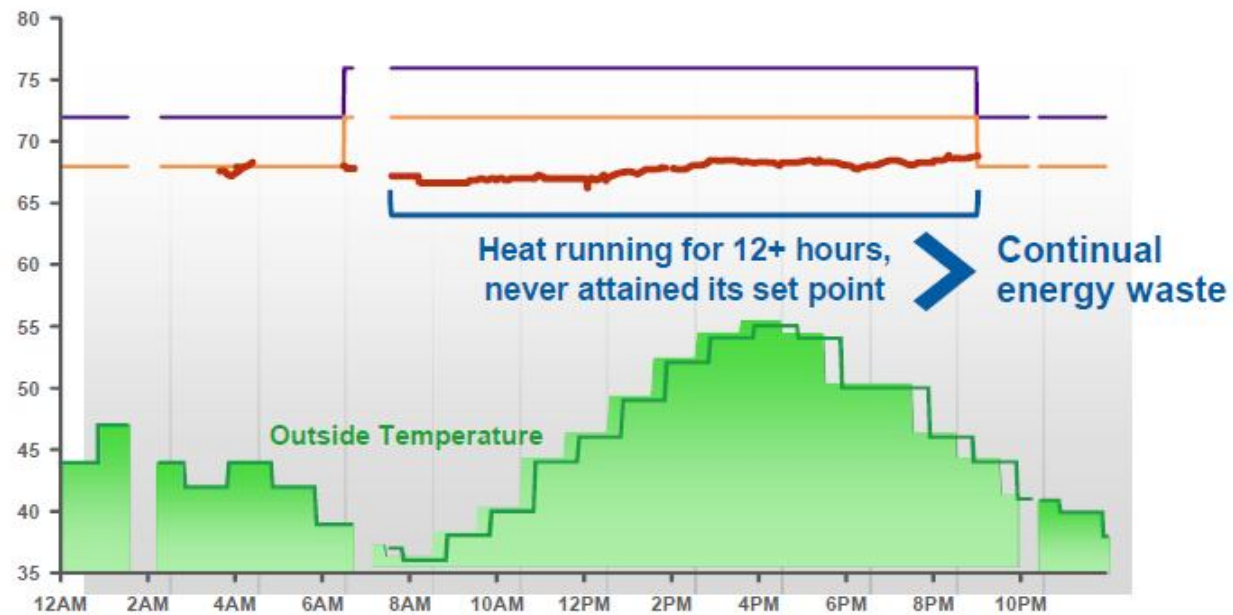
Smart Thermostats w/ Diagnostics Capabilities

| Comparison | RT Automation | Company XYZ |
|---|---|--|
| Product | MCerberus® HVAC Monitoring System | Company XYZ HVAC Monitoring Service |
| Pricing | Current - \$299 Hardware Only | Not provided |
| Service Fee | None | Not provided but website infers that monthly service fee applies |
| Availability | No Limit Installation on any Central HVAC | Limited to Channel Partners |
| Installation | Installs directly on/next to HVAC System (Invisible to Consumer) | Replacement of Thermostat |
| Measurement Method | Direct: Heat Exchanger Temp In, Heat Exchanger Temp Out, and Current | Measured Room Temp, ON/OFF Signal, thermostat setpoint Inferred signals via Internet |
| Communication | WiFi | WiFi |
| Analysis | Backoffice program provided to HVAC Contractor and Consumer at no additional charge | Backoffice analysis completed by Company XYZ on a weekly basis. Results emailed to Channel Partners |
| Time required to determine fault from time of installation | < 24 hours for min/max delta T 72 hours for statistical variations | Days to weeks since algorithms require "learning" with regards to the installation |
| "Reliability" | 99+ percent goal | 94 percent (**) |

Smart Thermostat Diagnostics Algorithm Leads to False Failures

HVAC Remote Diagnostics Service

Identify **underperforming** and **degrading** HVAC systems



MCerberus® Target Market

- Nationwide
 - Air Conditioning in 100M US Homes (www.eia.gov – 2011 Survey)
 - 62% of these systems have Central HVAC installed (62M units)
 - Target Market is 0.1 percent of these installation (620K units)
- San Antonio
 - 1.47M population as of July, 2015 (www.suburbanstats.org)
 - Number of occupied homes = 479K
 - Using www.eia.gov statistics, number of Central HVAC installations = 270K single family homes
 - Target market in SA is 1 percent * 270K = 2,700 units

Excess Power Generation Calculation

Excess Power Generation (Peak) is 98MW estimated for CPS Energy to support derated/non-optimal HVAC Operation assuming 10 percent of single family homes in SA have derated systems

| Item | Units | Value |
|--|-----------|-----------|
| Number of Single Family Homes in SA with Central HVAC | unity | 270,000 |
| Assume 10% of the Single Family Homes in SA have derated AC Systems | unity | 27,000 |
| Excess KWH required due to derated/non-optimum operation of HVAC | KWH | 678 |
| At the CPS Level -- Total excess power generation required (one month) | MWH | 18,310 |
| Excess Power Generation Required (avg over the month @ 6 hours/day) | MW | 98 |
| CPS Peak Demand on August, 2016 (http://www.sanantonioedf.com/regional/utilities/) | MW | 5,017 |
| Net reduction | % | 1.96% |

Capital Cost Equivalents to generate 98MW

| Item | Conv Comb Turbine | Wind | Photovoltaic | mCerberus® |
|----------------------|-------------------|---------------|---------------|--------------|
| Capital Cost (\$/MW) | \$ 672,000 | \$ 1,686,000 | \$ 2,277,000 | \$ 548,265 |
| Required (MW) | 98 | 98 | 98 | 98 |
| Total | \$65,856,000 | \$165,228,000 | \$223,146,000 | \$53,730,000 |

Source: Cost and Performance Characteristics of New Generating Technology, 2017 US Energy Department

RT AUTOMATION

We make automation simple™

Ron Roth, Ph.D.

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