WP Thermostats: Non-Invasive Pneumatic To Digital Retrofit

Includes

SMARTPneumatics

Fault Detection Analytics Software for Pneumatic HVAC Controls

Improve Tenant Comfort
Increase Energy Efficiency
Reduce Maintenance Effort
Enable Demand Response
Gain LEED Points

CYPRESS ENVIROSYSTEMS™

Mike Romanco, Cypress Envirosystems
Mike.Romanco@CypressEnvirosystems.com
(630) 388-8938
www.CypressEnvirosystems.com

Who is Cypress Envirosystems?

Our Heritage
- Former Subsidiary of Cypress Semiconductor (NASDAQ: CY)
    - Quality-driven processes
    - Deep technology experience: Cypress wireless devices are in 100 million devices all around us
- Spun off 2009 (private and employee owned)

Our Leadership
- CEO: Harry Sim, ex-Honeywell executive (15yrs.)
- Executive staff: Over 130 years of facilities and energy experience

Our Mission
- Modernize existing facilities
- Develop technologies that must:
    - ✓ **Be non-invasive and install in minutes**
    - ✓ **Cost 60-80% less than alternative solutions**
    - ✓ **Solutions that pay back in ~ 18 to 24 months**

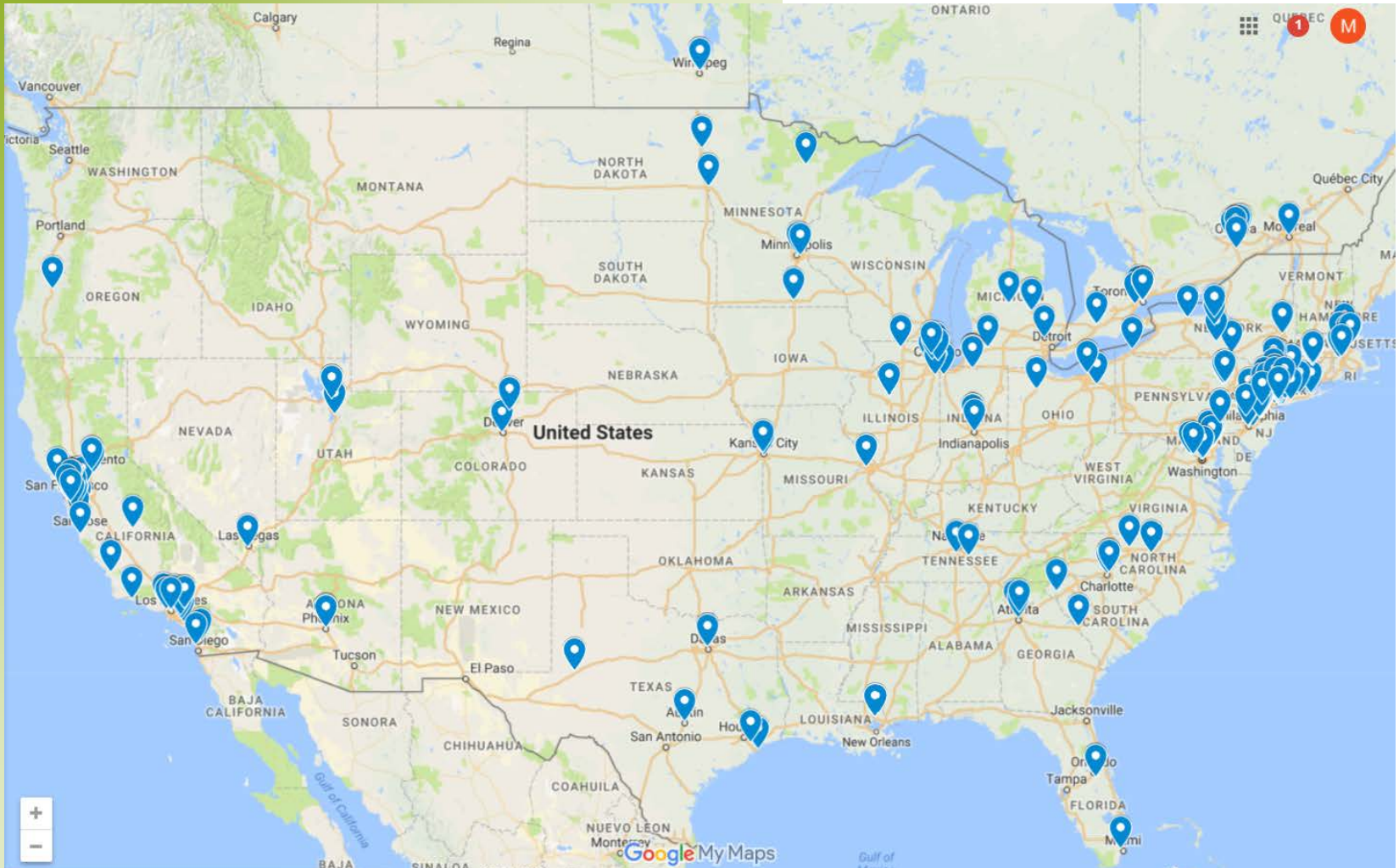Cutting Edge Silicon Valley Technology
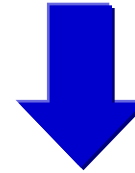
Applied to Legacy Facilities

100,000,000 SF+ WPT Installed Base

Challenges with Pneumatic HVAC Controls

Pneumatic thermostats:

- No monitoring, limited visibility to occupant spaces

- No remote control = manual response to hot/cold calls

- No BACnet connection to thermostats

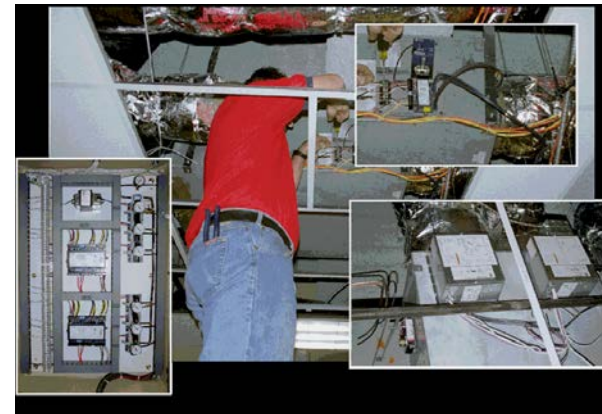- Limited ability to implement energy savings strategies

Most Commercial Buildings Still Employ Pneumatics

70% of Buildings Still Use Pneumatic Stats
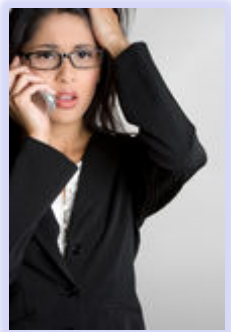
30% Use Electronic Stats
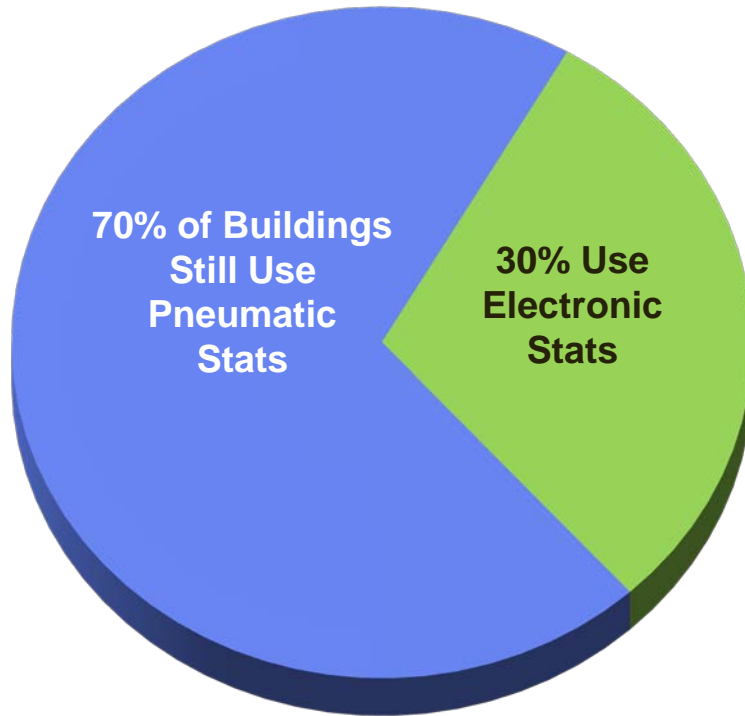
Why so many pneumatics still?

- Most Buildings constructed before 1999

- Conventional DDC retrofit too disruptive to occupants

- Requires opening up walls & ceilings, replacing actuators, running wires

- Very expensive, >$2,500 per stat

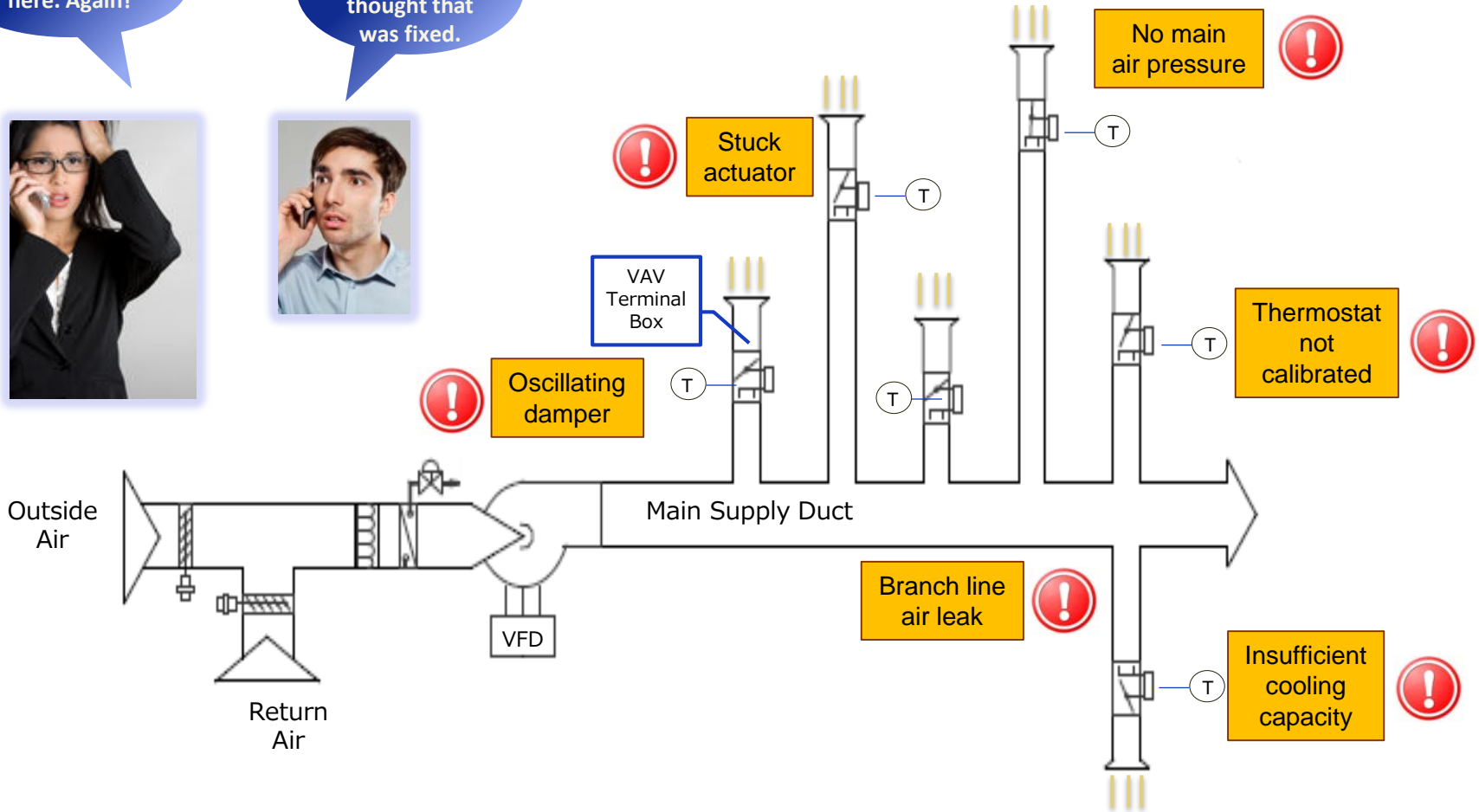- Payback period >10 years . Thus, typically not economical.

Facility Managers Cannot see lurking issues...

Hard to implement Energy Savings Strategies

Compared to Fully Digital Buildings, pneumatically controlled buildings use 20-30% more energy

No remote control
No programmability

- ✘ Temperature Setpoint Enforcement
- ✘ Separate Heating and Cooling Setpoints
- ✘ Programmable Occupancy Schedules
- ✘ Auto Demand Response (zone level)
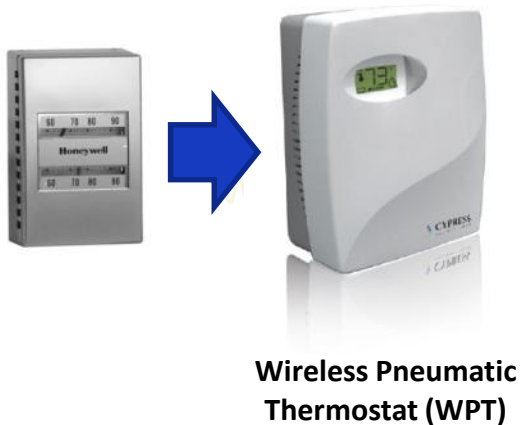
No/Limited zone sensor data

- ? Duct Static Pressure Control
- ? Supply Air Temperature Resets
- ? Optimal Start/Stop

CYPRESS ENVIROSYSTEMS

How to help these existing buildings...

STEP 1

Non-Invasive retrofit existing thermostats to WPT

Wireless Pneumatic Thermostat (WPT)

STEP 2

Analyze your pneumatic system for faults

SMARTPneumatics

- Stuck actuators?
- Need calibration?
- Supply air leak?
- Oscillating dampers?
- Air system contamination?
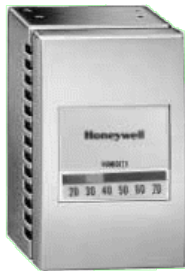- Insufficient cooling?

STEP 3

Implement
Energy Savings Strategies

- Setpoint Enforcement
- Separate Heat/Cool Setpoints
- Programmable Schedules
- Auto Demand Response
- Duct Static Pressure Reset
- Supply Air Temperature Reset
- Optimal Start/Stop

CYPRESS
ENVIROSYSTEMS

Non-Invasive Pneumatic to Digital Retrofit

EXISTING LEGACY STAT

CYPRESS ENVIROSYSTEMS
WIRELESS PNEUMATIC THERMOSTAT

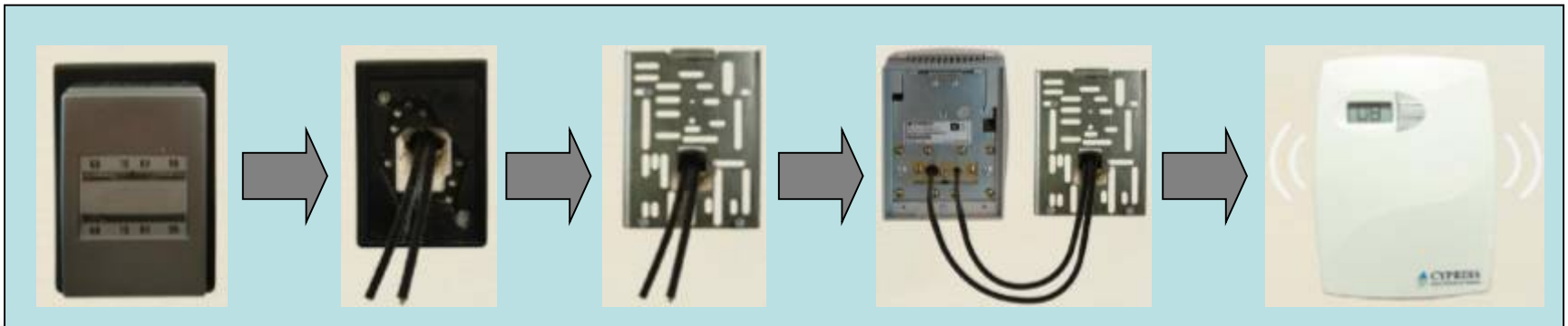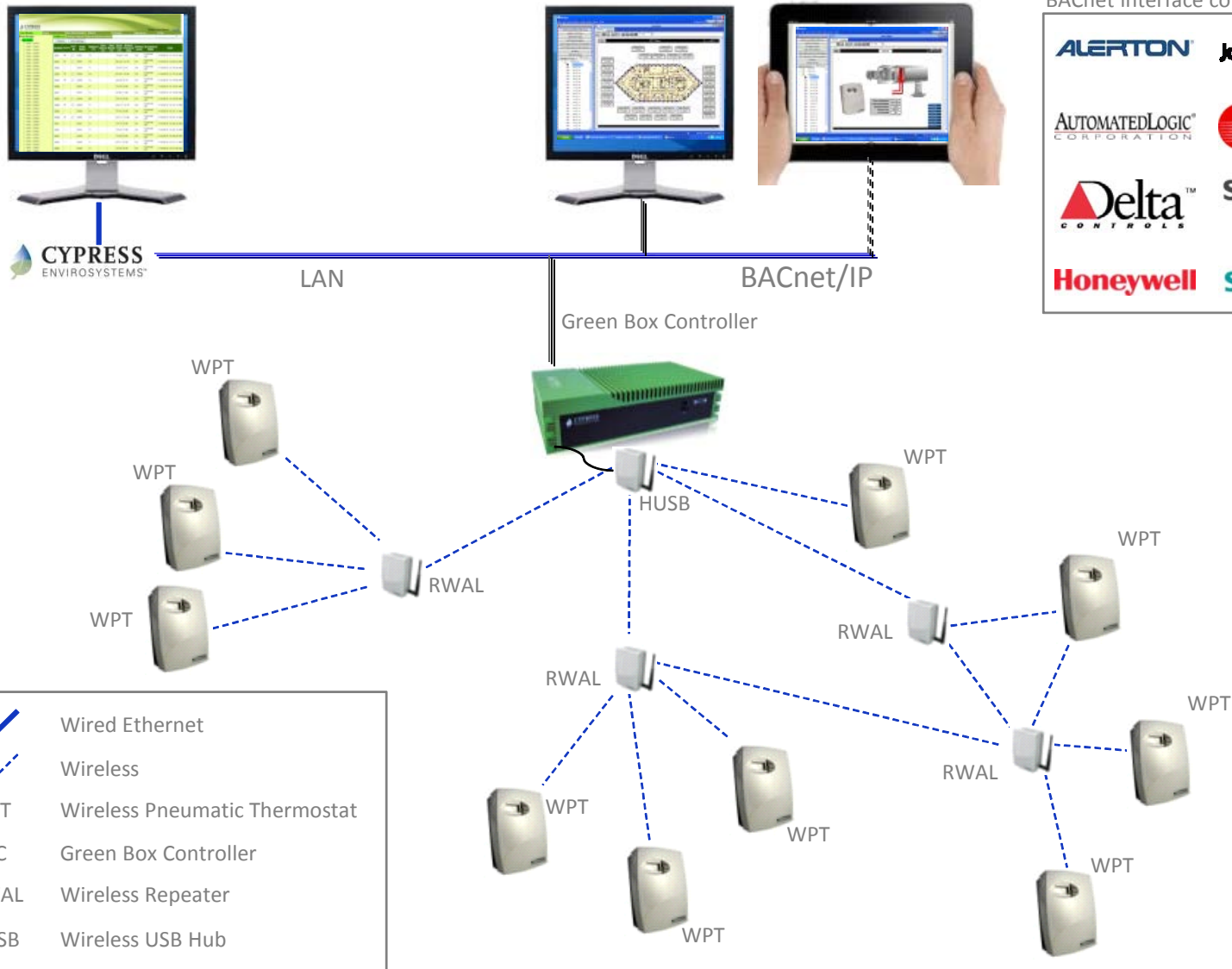*DDC in 20 Minutes!*

- Manual control, non-communicating
- No fault detection, no energy savings strategies
- Manual Calibration Required

- Remote Monitoring, Alarming, Control
- BACnet Integration with 3rd party BAS
- Automatic Self-calibration
- Programmable energy savings, demand response

Simply remove existing thermostat from wall, connect WPT, activate wireless interface

CYPRESS
ENVIROSYSTEMS

Digital Pneumatics (WPT) Architecture

BACnet interface compatible with:

ALERTON   Johnson Controls
AUTOMATEDLOGIC CORPORATION   TRANE
Delta CONTROLS   Schneider Electric
Honeywell   SIEMENS

LAN   BACnet/IP

Green Box Controller

WPT
WPT
WPT
RWAL
WPT
HUSB
WPT
WPT
RWAL
WPT
RWAL
WPT
WPT
WPT
RWAL
WPT
WPT
WPT
WPT

▬	Wired Ethernet
╱	Wireless
WPT	Wireless Pneumatic Thermostat
GBC	Green Box Controller
RWAL	Wireless Repeater
HUSB	Wireless USB Hub

CYPRESS ENVIROSYSTEMS

SMARTPneumatics Analytics

1

Wireless Pneumatic Thermostat collects extensive sensor and operational data on zone temperatures, setpoints, occupancy modes, air pressure etc.

Adjust Setpoint(s) to More "Reasonable" Temperature

NodeID	Description	Recommended Action
118	O'Brien Rm 25	Cool Above Setpoint is too low (63F). Try adjusting.
119	O'Brien Rm 27	Cool Above Setpoint is too low (63F). Try adjusting.

Check for Oil in Pneumatic Lines

NodeID	Description	Recommended Action
113	O'Brien Rm23	May need to clean system, install new filter/dryers, replace WPT.

Actuators May be Stuck

NodeID	Description	Recommended Action
118	O'Brien Rm 25	Check Heating Actuator - may be stuck open
117	O'Brien Rm 30	Check Heating Actuator - may be stuck open

Check Thermostat Calibration

NodeID	Description	Recommended Action
116	O'Brien Rm 28	Check thermostat calibration - 4.1 deg F offset

Advanced patent pending analytics software perform fault detection diagnostics and produces easy to read actionable report.

2

CYPRESS
ENVIROSYSTEMS

See the big picture and drill down on problems

Zone 0116 not able to maintain setpoint

Zone 0118 Insufficient cool air flow

	Type of WPT	WPT Action	Sample Rate	Maintain Setpoint? (ABS DeltaT deg)	Heating Setpoint Suspect? (deg)	Cooling Setpoint Suspect? (deg)	WPT Calibrated? (psi error)	Main Pressure OK (psi)?	Oil in Line? (sticking psi)	Heating Actuator Stuck Open/Uncal?	Cooling Actuator Stuck Open/Uncal?	Insufficient Heating Capacity?	Insufficient Cooling Capacity?	Low Batt?	Wire-less Missed Comm?
0116	Conv	Direct	0:33	4.7	67	67	1.3	15.3	1.6	FALSE	FALSE	FALSE	FALSE	OK	5.4%
0119	Conv	Direct	0:15	4.0	68	68	5.1	14.0	0.3	FALSE	FALSE	FALSE	FALSE	OK	0.2%
0118	Conv	Direct	0:22	3.2	70	70	2.4	14.2	0.8	FALSE	FALSE	FALSE	TRUE	OK	1.1%
0114	Conv	Direct	0:16	2.9	68	68	3.0	15.3	1.1	FALSE	FALSE	FALSE	FALSE	OK	1.7%
0117	Conv	Direct	10:28	2.4	71	71	2.2	15.3	0.3	FALSE	FALSE	FALSE	FALSE	OK	56.5%
011A	Conv	Direct	0:45	1.3	71	71	2.6	12.4	0.3	FALSE	FALSE	FALSE	FALSE	OK	8.5%
0113	Conv	Direct	0:17	1.0	70	70	1.4	15.3	0.0	FALSE	FALSE	FALSE	FALSE	OK	2.7%

Zone 0119 thermostat requires calibration

CYPRESS
ENVIROSYSTEMS

SmartPneumatics Reduces Hot/Cold Calls

Becomes a software tool for on-going 'commissioning'

- 17,000 sq-ft Class A Office Space, 31st Floor
- 48 Story Hi-Rise, managed by Cushman & Wakefield
- San Francisco Financial District
- Tenant: Private Equity Firm

Pre-WPT Installation
Mar - Nov

Post-WPT Installation
Mar – Nov

W.O #	DATE	TENANT	FLOOR	OFFICE #	REQUEST	TEMP.	WORK PERFORMED	BY	#
148516	9-Mar-09		31	3115	COLD		FOUND STAT PUTTING OUT 1#	JIM	1
150125	6-Apr-09		31	LARGE CONF.	PRE COOL		PUT STAT INTO COOLING FOR MTNG.	TIM	2
150195	8-Apr-09		31	CONF ROOM	COLD		CAL. T-STAT AND SET TO 70-74	PAUL	3
150500	15-Apr-09		31	3146	COLD	70	OFFICE TEMP. WAS 70	PAUL	4
151016	27-Apr-09		31	3155	COLD	71	TEMP. WAS 71	FRAZER	5
153307	15-Jun-09		31	CONF ROOM	HOT	73	AMBIENT 73 LOWERED STAT TO 65/70	PAUL	6
153976	26-Jun-09		31	EAST CORNER	COLD	73	RM TEMP 73 RAISED STAT TO 74	JIM	7
153991	26-Jun-09		31	PINE SIDE	COLD	73	AREA TEMP. 73, RAISED STAT TO 74	JIM	8
N/A	6-Jul-09		31	3156	COLD	71	OFFICE TEMP. WAS 71	PAUL	9
154347	7-Jul-09		31	S. ADMIN	COLD	72	AREA TEMP WAS 72	C.W/ PF	10
155020	22-Jul-09		31	3115	COLD	71	AREA TEMP AT 71 F, T'STAT AT 75 F	ART	11
155582	5-Aug-09		31	3134-A	COLD	73	AREA TEMP WAS 73.	CRAIG	12
155597	5-Aug-09		31	N CONF RM.	COLD		T'STAT SET TO 65-69, RESET TO 70-73	ARTURO	13
155597	5-Aug-09		31	NORTH CONF RM	COLD	68	TEMP. WAS 68 RESET TO 70-73	ART	14
155808	12-Aug-09		31	3104	HOT		RE-SET STAT TO 71-74, FROM 70-74	CRAIG	15
157113	8-Sep-09		31	3127	HOT		CAL. STAT AND SET TO 71-74	CRAIG	16
157849	30-Sep-09		31	CAL. ST. SIDE	COLD		CAL. AND SET STAT TO 75	CRAIG	17
158278	6-Oct-09		31	3134A	COLD		REDUCED CFM, REDIRECTED AIR FLOW	C.W./S.T.	18
158192	7-Oct-09		31	3134A	COLD	74	TEMP.IS 74 ADJUSTED TWO STATS IN AREA	ART	19
158563	16-Oct-09		31	EAST CORNER	HOT	73	SET STAT TO 73	GRAIG	20
159030	27-Oct-09		31	3152	HOT	71	OFFICE TEMP. WAS 71	PAUL	21
159095	29-Oct-09		31	EAST CORNER	COLD	72.5	AREA TEMP WAS 72.5	ARTURO	22
159113	29-Oct-09		31	3146	HOT		DECREASED STPT TO 71-74 FROM 71-75	ARTURO	23
159222	2-Nov-09		31	3146A	HOT		CHILLER STARTED AT 10:45	ARTURO	24
159222	2-Nov-09		31	3146A	WARM	73	AREA TEMP WAS 73. MADE NO ADJ.	ARTURO	25
159240	2-Nov-09		31	WEST ADMIN	WARM	71.5	AREA TEMP. WAS 71.5 MADE NO ADJ.	PAUL	26
159321	3-Nov-09		31	3143/3140	WARM	72.5	AREA TEMP. WAS 72.5 MADE NO ADJ.	PAUL	27
159759	13-Nov-09		31	N CONF RM.	COLD	69	INCREASED SPT TO 71-74, FROM 69-73	ARTURO	28
159854	17-Nov-09		31	N CONF RM.	COLD	69	CAL. AND SET STAT TO 71-74	CRAIG	29

W.O #	DATE	TENANT	FLOOR	OFFICE #	REQUEST	TEMP.	WORK PERFORMED	BY	#
164055	1-Mar-10		31	3155	COLD	69	NEW W.P.T. WAS SET AT 71, SET TO 74	PAUL	1
164473	5-Mar-10		31	3113	COLD	71	FOUND COAT HANGING OVER T-STAT	PHIL	2
164916	12-Mar-10		31	3134A	COLD	72	SUPPLY AIR AT 68F STAT SET @ 72, RAISED TO 73	ART	3
165486	25-Mar-10		31	3120A & B	COLD	72	RAISED SPT. TO 73	CRAIG	4
166825	27-Apr-10		31	3120A & B	COLD	72	WPT WAS SET TO 73, RAISED TO 74	PAUL	5
166853	27-Apr-10		31	3121	HOT	77	UNABLE TO CALIBRATE WPT WIIL FOLLOW-UP	PHIL	6
166994	3-May-10		31	3121	HOT	76	FOLLOW-UP TO REPLACEMENT OF WPT BY	CRAIG	7
169919	28-Jun-10		31	3155	COLD	70	RESET STAT TO 72	CRAIG	8
174033	27-Sep-10		31	PINE SIDE	HOT	80	CALIBRATED (3X) STATS AND SET AT 70 F.	CRAIG	9
176108	17-Nov-10		31	3155	COLD	70	STAT WAS SET @ 71 RAISED TO 73	PAUL	10

- ✓ **66% reduction in hot/cold calls**
- ✓ 25 avoided calls/year
- ✓ 7-10¢/sq-ft/year savings

CUSHMAN & WAKEFIELD®

CYPRESS ENVIROSYSTEMS

Benefits of SMARTPneumatics

- Saves energy by identifying energy consuming faults

- Enhances occupant comfort; reduces FM labor costs

- Reduces maintenance labor and hot/cold calls

- Spots problems to avoid damage to equipment

- Meets LEED ongoing commissioning requirements

CYPRESS
ENVIROSYSTEMS

Typical Energy Savings Strategies:
20-30% HVAC Energy Reduction, 1 to 3 Yr Paybacks

Savings

Energy
- Temp Setpoint Policy
- Night/ Weekend Setback & Occupancy Override
- Retro Commis-sioning/ Diag-nostics
- Deadband Temp Policy
- Auto-Demand Respond Peak Load Shedding
- Duct Static Pressure & Supply Air Temp Reset
- Optimal Start/ Stop

Maintenance
- Auto Calibration
- Reduced Occupant Complaints
- Faster Trouble Shooting, Fault Detection

Standalone Capability (typically 75% of savings)

Requires BMS Connectivity

Standalone Capability

Same Benefits as Direct Digital Control –
but at a Fraction of the Price and Disruption

CYPRESS
ENVIROSYSTEMS

311 S. Wacker Drive

- **What was installed? How was it done?**

  1050 existing pneumatic thermostats replaced with Wireless Pneumatic Thermostats and integrated with Andover Continuum Building Management System and JLL IntelliCommand Smart Building system.

- **How long did it take?**

  6 weeks to complete 65 stories

- **How much did it cost?**

  $1.00 per sq-ft

- **What was the savings?**

  Projected savings was 26% of HVAC consumption Actual savings measured was approximately 29% over initial 18 months. (most recently 32%)

- **What was the payback period?**

 Payback period with ComEd rebate was 1.4 years.

CYPRESS
ENVIROSYSTEMS

311 S. Wacker Drive: **Performance Results**

Actual Measured:
Energy Savings Exceeded Business Case by 10%

	kWh/Year	Savings (kWh/yr)	Savings ($/yr)	Savings ($/sq-ft)	HVAC Energy Reduction
Baseline without WPT	17.9 million	-	-	-	-
Target business case	15.8 million	2.1 million	$214,110	$0.14	26%
Actual M&V with WPT	15.5 million	2.4 million	$234,677	$0.16	29%
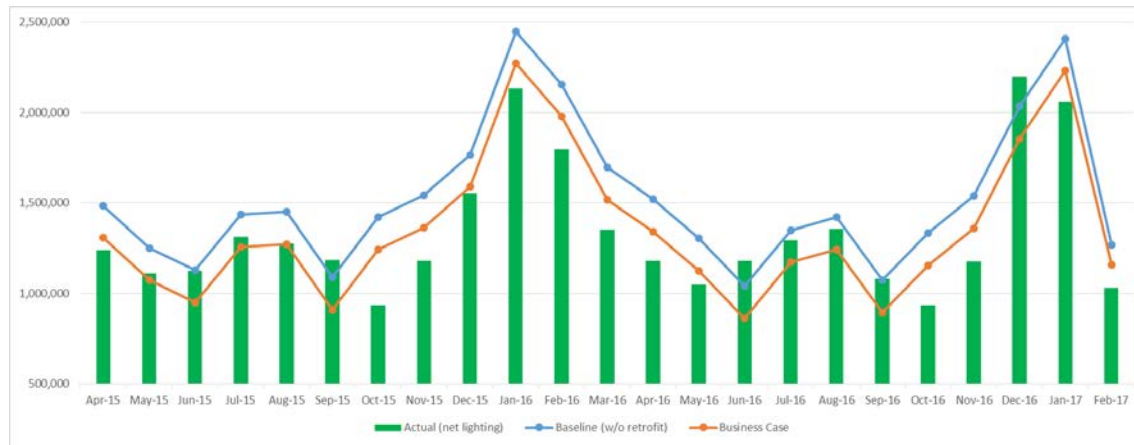
Demand Response (example) via WPT's
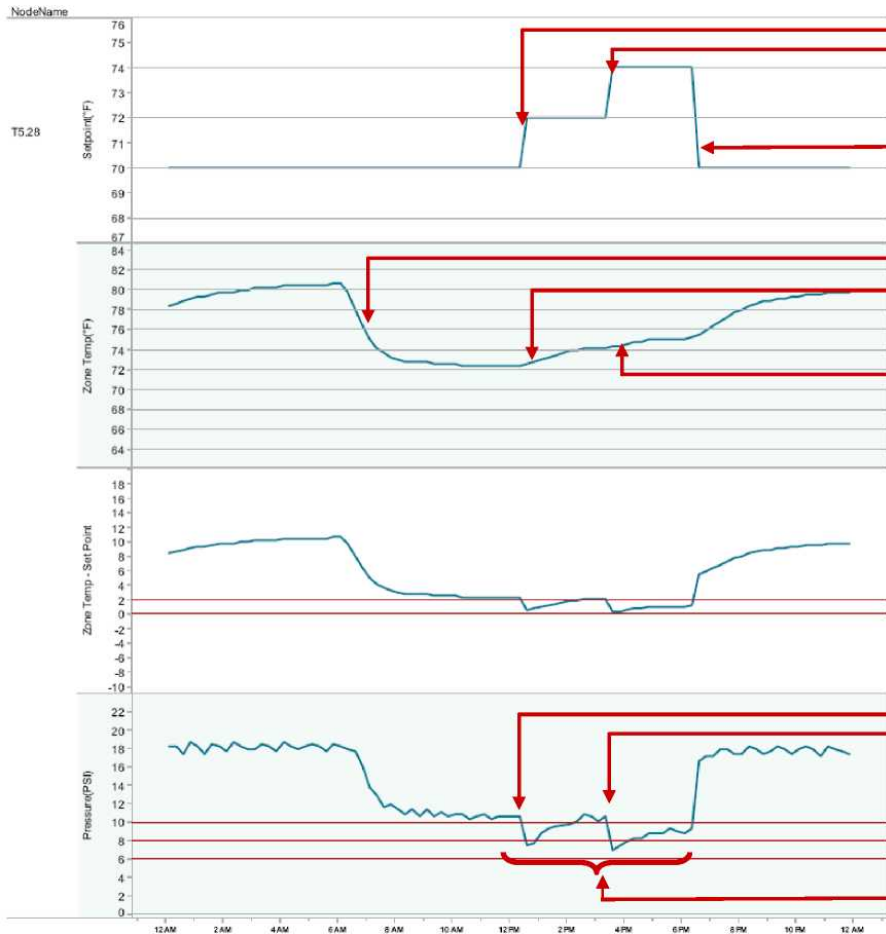
SETPOINT TEMPERATURE
- 1st DR Event bumped up setpoint 2 deg
- 2nd DR Event bumped up additional 2 deg

- Completion of Event - back to normal

ZONE TEMPERATURE
- Morning A/C comes on
- Temp climbs after initial DR event

- Continues climbing after 2nd DR event

DELTA SETPOINT MINUS ZONE TEMP
- Should maintain to within 2 degrees of setpoint throughout

BRANCH PRESSURE
- Drops after first event called
- Drops after second event called

- Stays about neutral 8psi during entire DR period.

CYPRESS
ENVIROSYSTEMS

Hi-Rise Building Installations Nationwide

- Proven installations at prestigious buildings nationwide

- Utility rebates in most states

- 15-30% HVAC energy savings typical

- Three year (or less) payback time typical in midwest

Phoenix	Chicago	New York	Toronto	San Francisco
Great American Tower	*311 S. Wacker*	*60 Wall St.*	*277 S. Wellington*	*345 California*

Example Customers

WPT Technology Recommended by DOE

Where does M&V recommend deploying Wireless Pneumatic Thermostats?

ANY FACILITY
WITH CONVENTIONAL PNEUMATIC CONTROLS
Deployment priority should be given to facilities with high energy costs

[1]Wireless Pneumatic Thermostat Evaluation, Ronald Reagan Building and International Trade Center, Washington, DC, Dan Howett, P.E., Mahabir Bhandari, PhD ORNL, March 2015, p. 2 [2]Ibid, p.3 [3]Ibid, p.4 [4]Ibid, p.4

GSA

GPG
Green Proving Ground Program

The Green Proving Ground program leverages GSA's real estate portfolio to evaluate innovative sustainable building technologies.
www.gsa.gov/gpg | gpg@gsa.gov

"Our wireless pneumatic thermostats are easy to use and cost-effective, and they provide access to energy-saving control strategies that weren't available through our old pneumatic system."

—Greg Dix
Building Manager, Ronald Reagan Building
Washington, D.C.
National Capital Region
U.S. General Services Administration

GSA

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

CYPRESS ENVIROSYSTEMS

Summary

- Pneumatically controlled buildings use more energy, require more maintenance, and provide lower tenant comfort

- Upgrading to conventional Direct Digital Controls (DDC) is extremely costly and disruptive to tenants

- Our Wireless Pneumatic Thermostat (WPT) provides a non-invasive upgrade solution which costs 70% less than conventional DDC

- Payback periods are typically three years or less – utility rebates, and where electric costs are above 11 cents/kwhr may deliver even shorter payback periods

- The Wireless Pneumatic Thermostat is proven technology which is tested and recommended by the US Dept of Energy and eligible for electric and gas rebates from numerous utilities nationwide

CYPRESS
ENVIROSYSTEMS

Thank you for your time !

Contact: Mike Romanco

Email: mike.romanco@cypressenvirosystems.com

Phone: (630) 388-8938

Web: www.CypressEnvirosystems.com