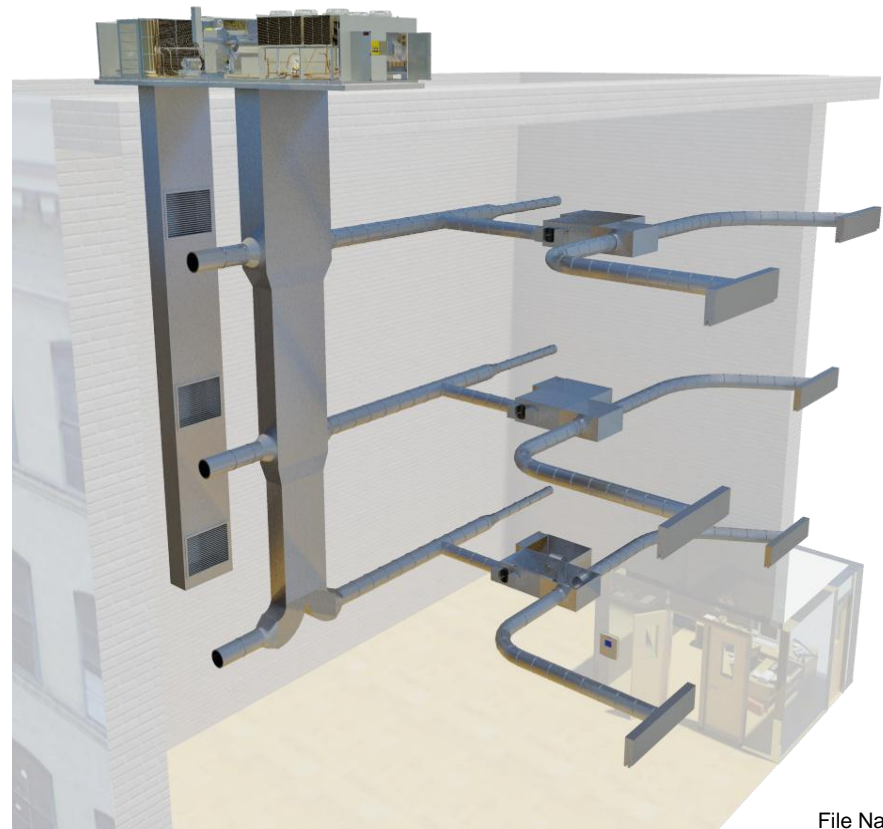


# VAV Systems

**Jeff Wotnosky**

**Trane Sales Engineer  
Raleigh, North Carolina**

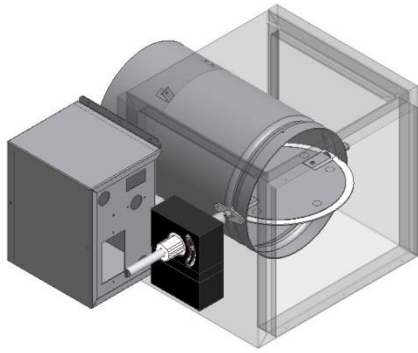


# VAV systems

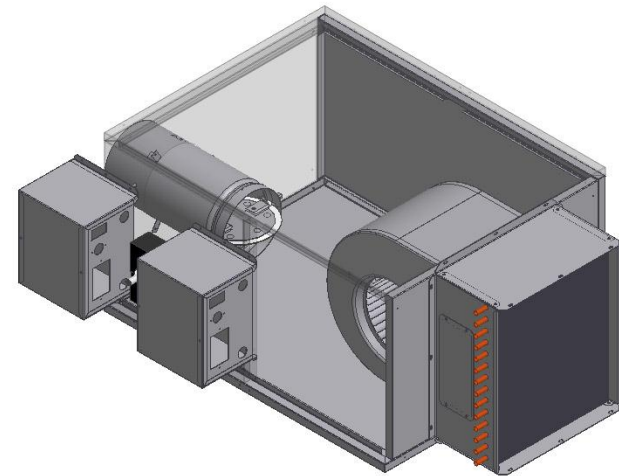
# Agenda

- **What is Variable Air Volume (VAV)**
- **Why(/Not) design VAV systems**
- **What buildings utilize VAV**
- **VAV system types and their components**
  - **Changeover Bypass ( Varitrac)**
  - **True VAV ( Varitrane)**
  - **Single Zone VAV**
- **System control considerations**
- **Leed and VAV**
- **Questions?**

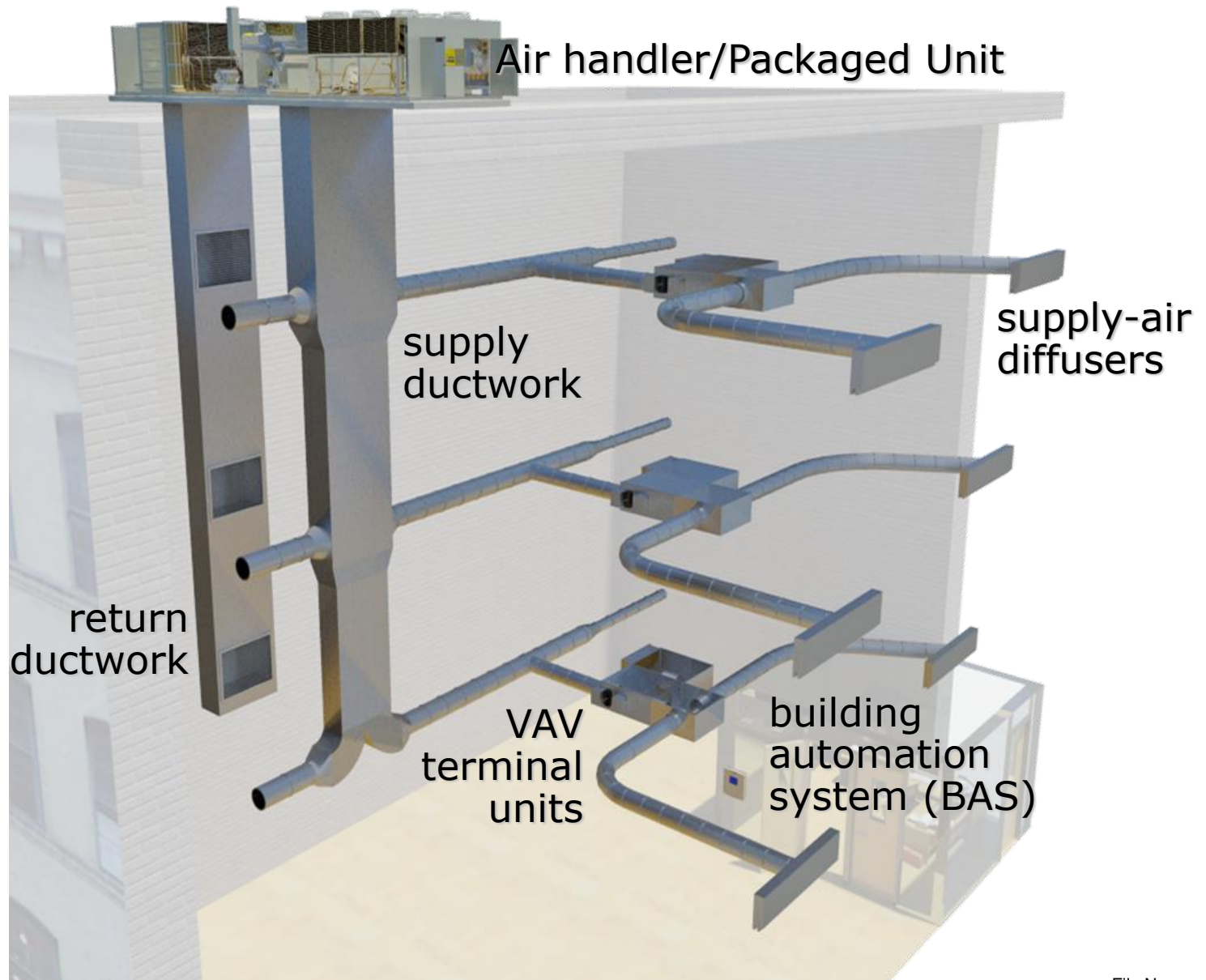




# What is Variable Air Volume(VAV) ?



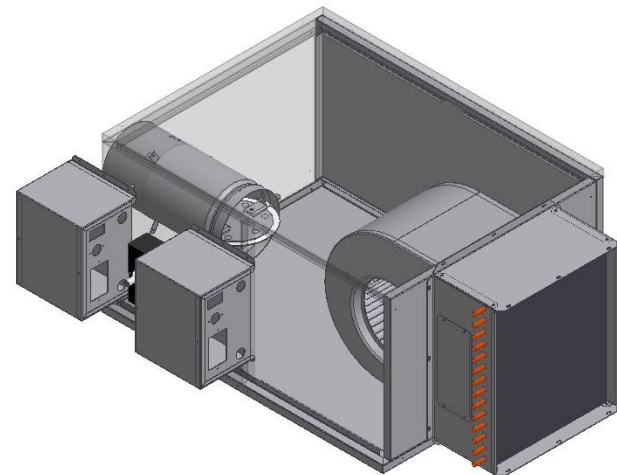
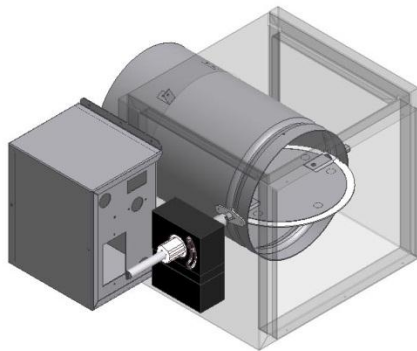
# VAV System

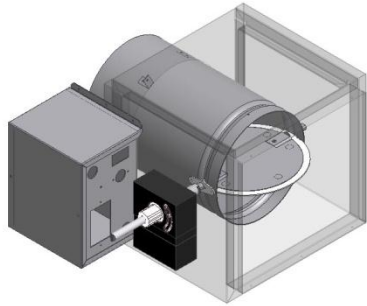


# Characterstics of VAV systems

**Constant air temperature off AC Unit**

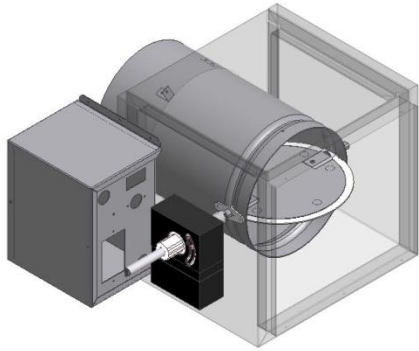
**Vary the air volume as load requires**





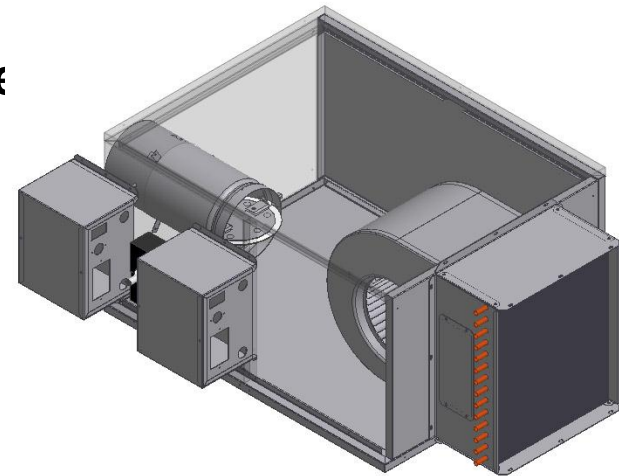
# Why use VAV?

- **Provides multiple zones of comfort**
- **Life cycle cost will be less than other HVAC Systems trying to accomplish similar comfort levels**
- **Load diversity**
  - **Smaller equipment ( lower AC unit first cost compared to Constant Volume)**
  - **Less supply air ( less energy consumption)**
- **Able to adapt to changes in building use**



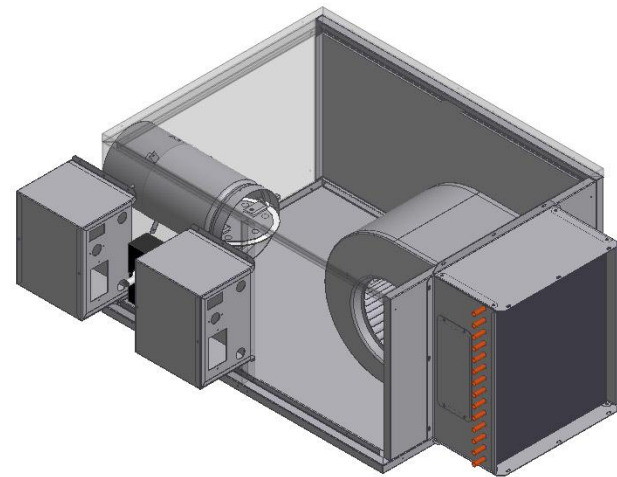
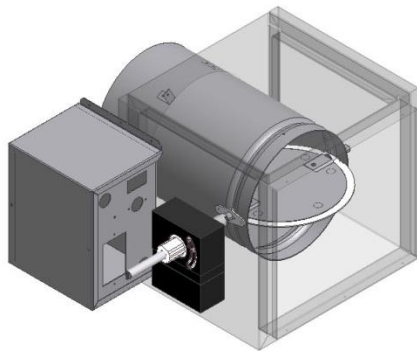
# Why Not ??

- **Higher first cost than comparable single zone**
  - **Controls, equipment, commissioning**
- **Increased maintenance cost**
  - **More pieces to look after**
  - **Terminal units might be located**



# Common places to use VAV systems

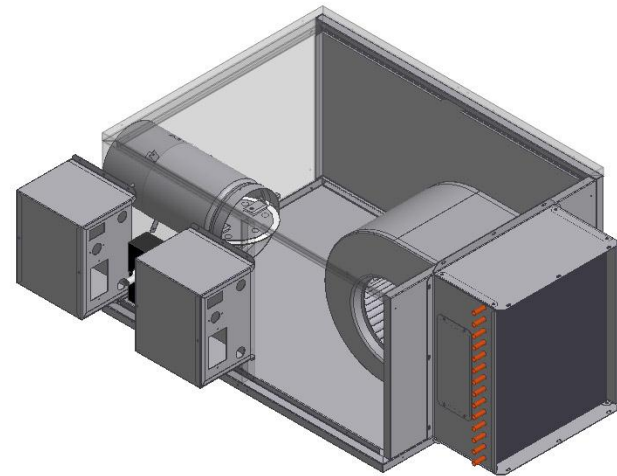
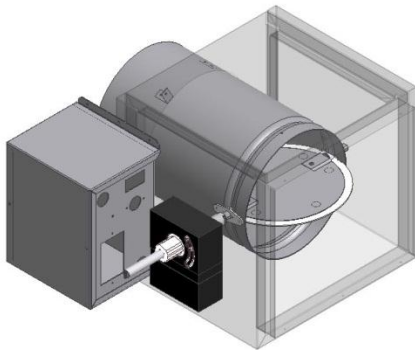
**Commercial/Medical Office buildings**  
**Schools ( all levels)**  
**Houses of worship**  
**Conference Centers**





# VAV System Types

**Changeover Bypass (Varitrac)**  
**“True VAV” (Varitrane)**  
**Single Zone VAV**



# VariTrac Changeover / Bypass System

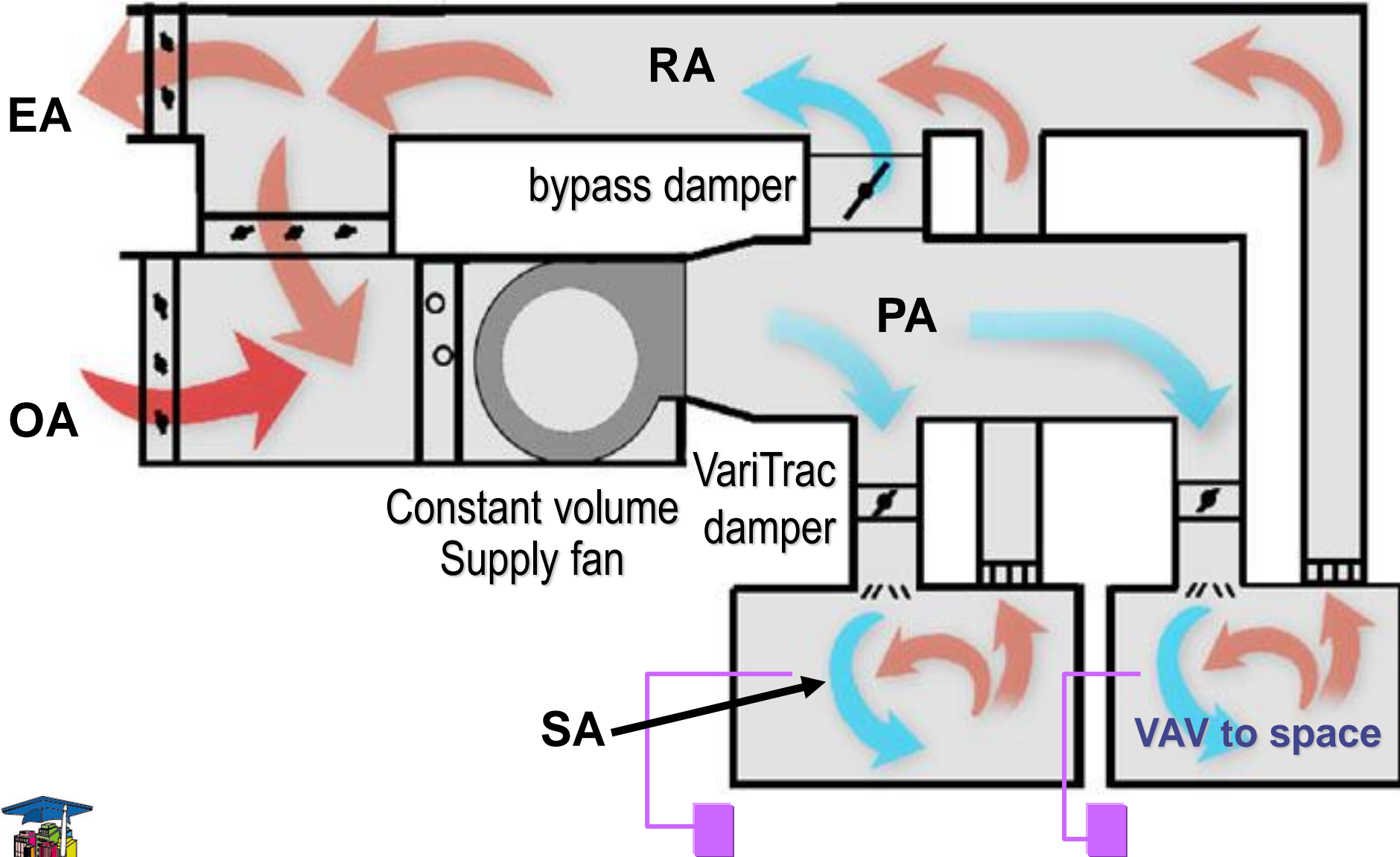


# What is VariTrac?

- **Cost Effective way to zone Standard packaged Rooftop units or Split Systems**
- **Often Driven by Light Commercial contractors:**
  - **Used to “Package Rooftop Equipment”**
  - **Desire somewhat simple installations and want to get on and off the job quickly.**
  - **Want to get a little more flexibility than their typical applications**

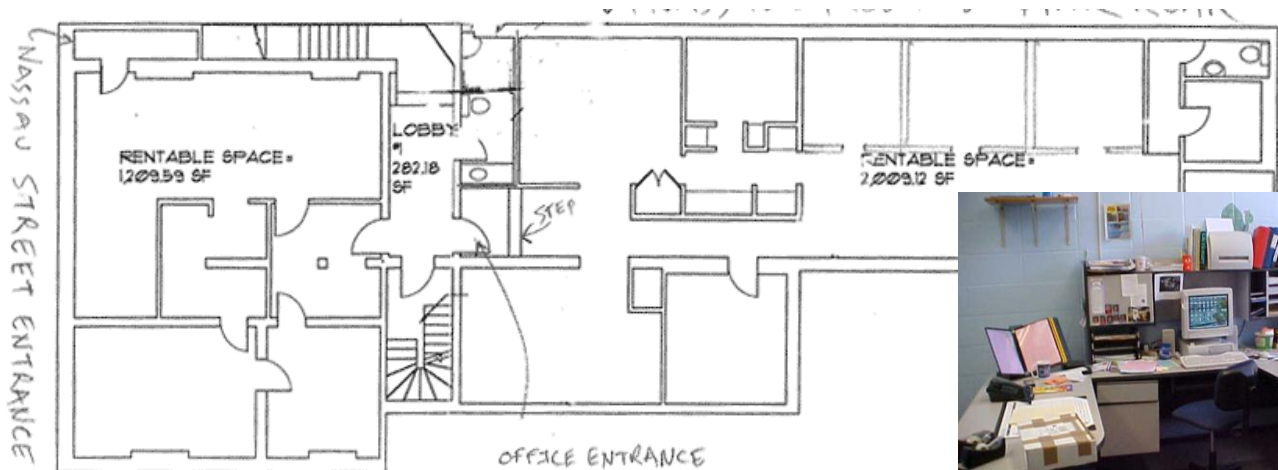
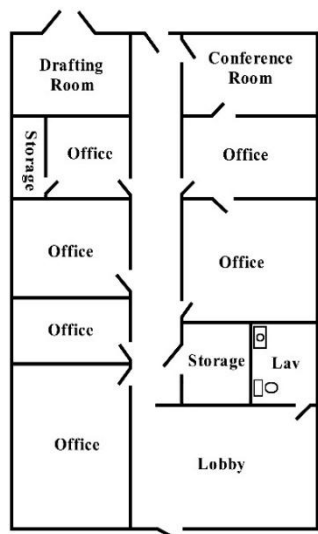


# Changeover/Bypass VAV System Layout

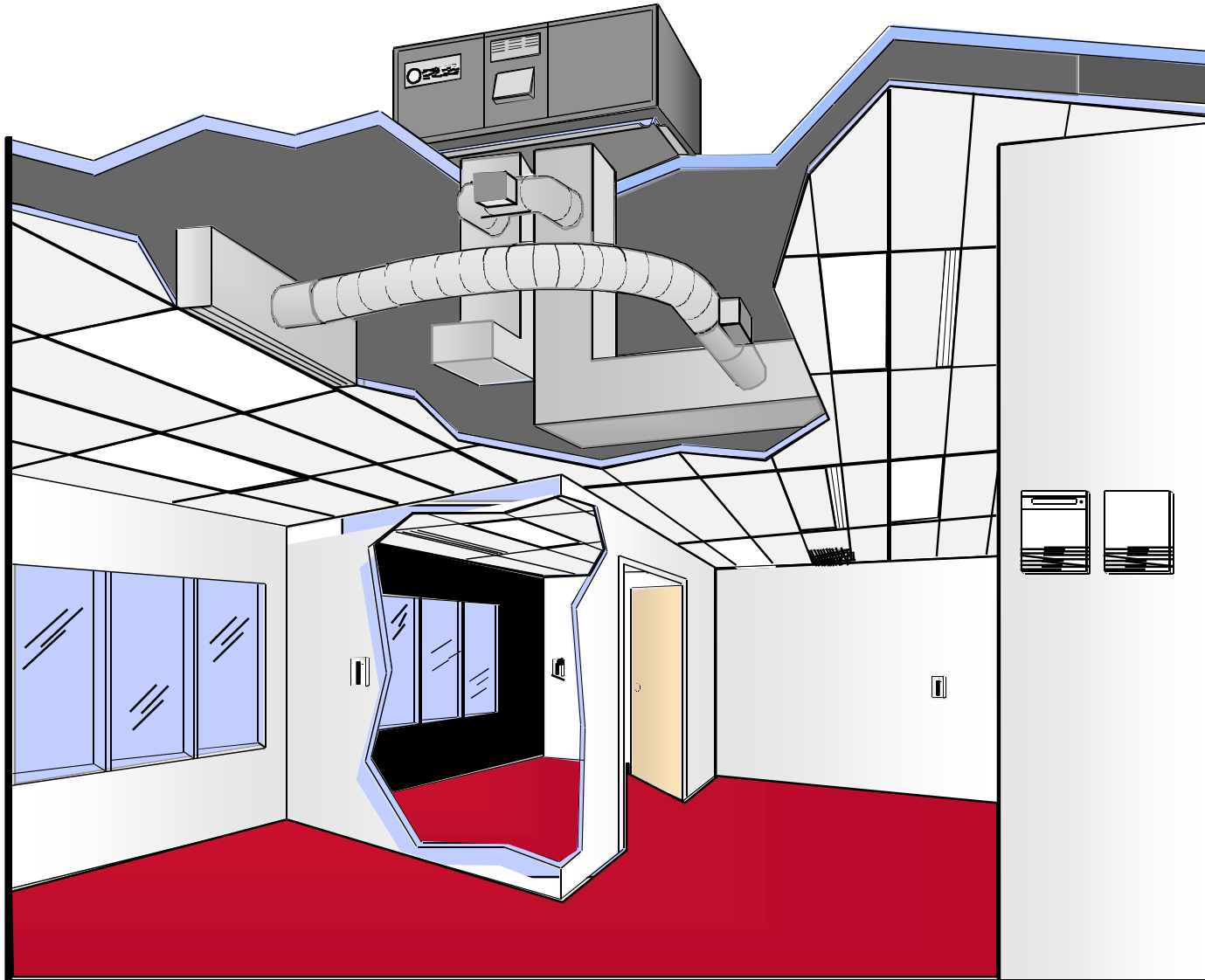


# Where would you use VariTrac?

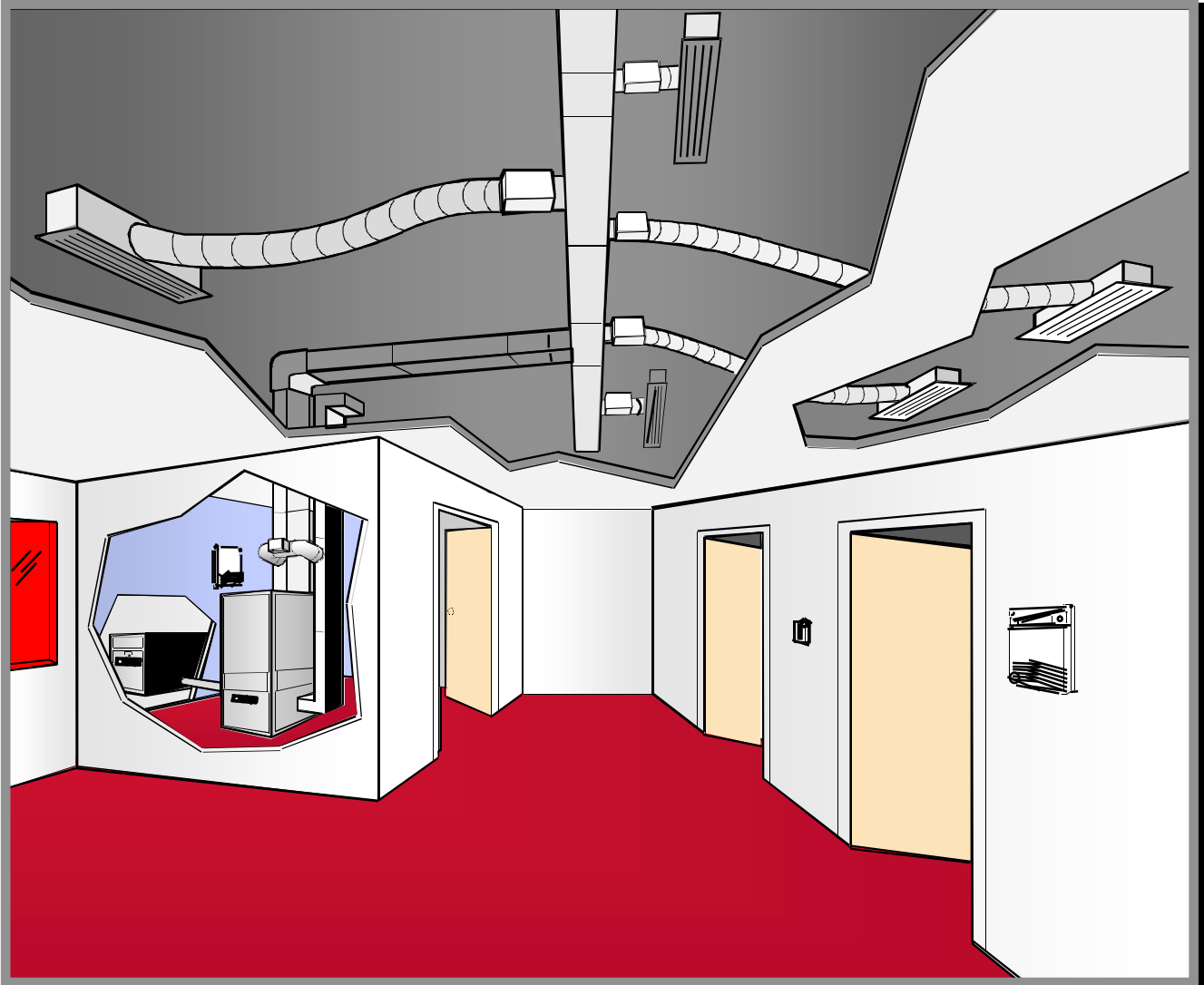
- **Ideal candidates for VariTrac Systems are:**
  - **one-story office buildings, clinics, movie theaters, strip malls, light manufacturing centers.**
  - **Examples are offices within a church, school, or manufacturing facility seeking individual (zoned) temperature control.**



# Light Commercial RTU



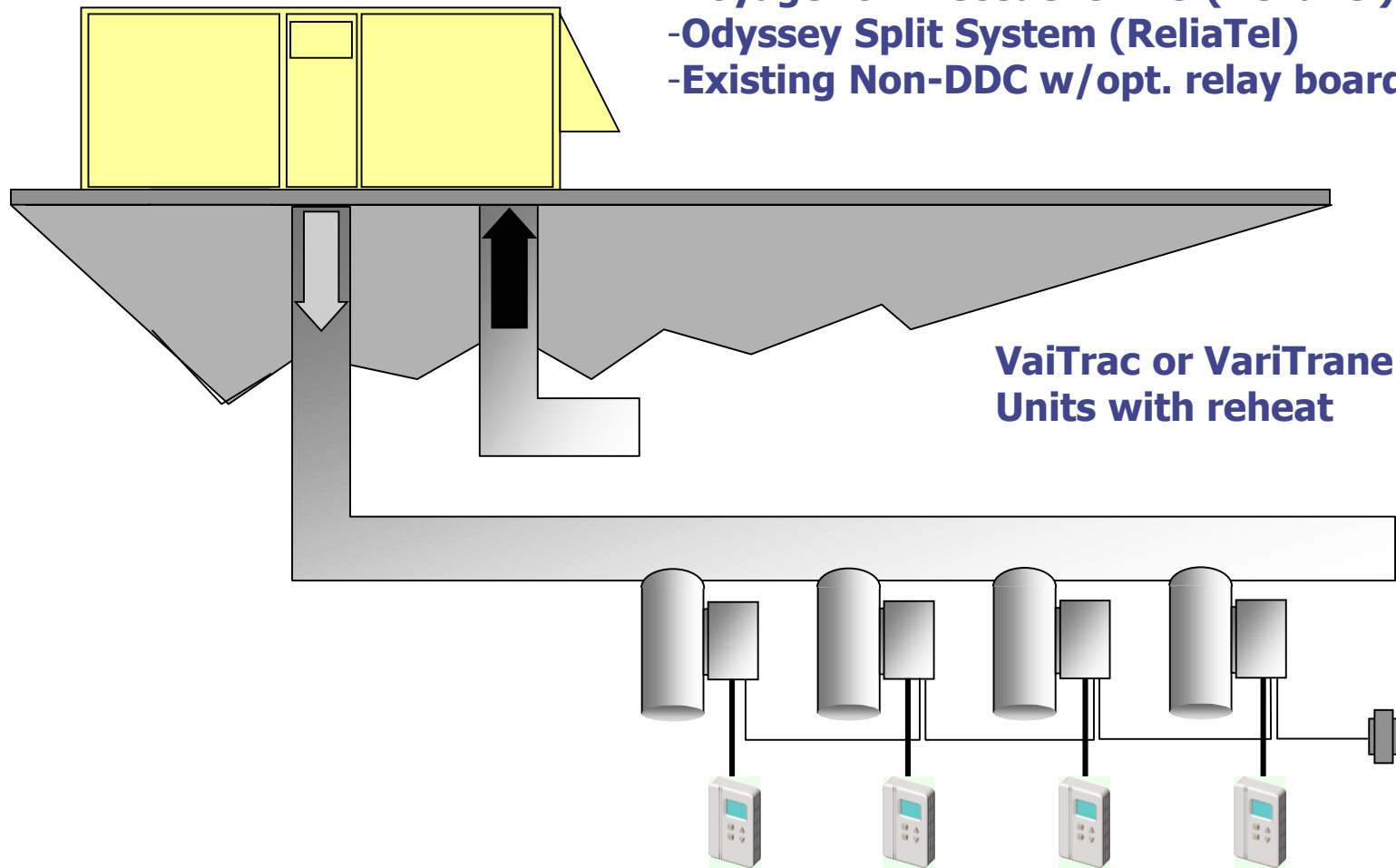
# Light Commercial Split System



# VariTrac Changeover Bypass System

## Main unit options:

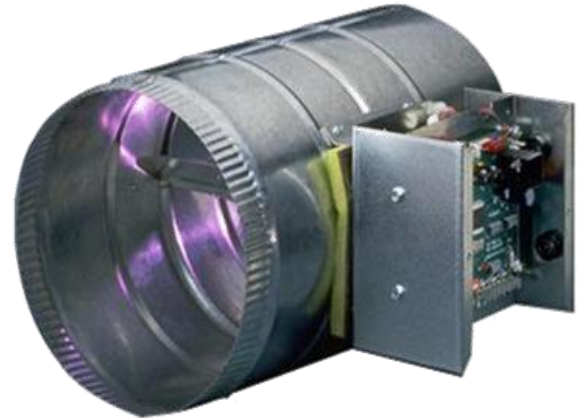
- Voyager or Precedent RTU (ReliaTel)
- Odyssey Split System (ReliaTel)
- Existing Non-DDC w/opt. relay board (CCP)





# VariTrac Dampers

- **Cooling only standard**
- **Trane Controller**
  - *Factory-installed, downloaded, and tested controller*
  - *Remote reheat control*
- **Round or Rectangular**
- **Airside**
  - *Pressure Dependent System (damper position control- no direct CFM measurement)*
  - *Up to 1.75" system pressure*



# Central Control Panel

- **“Self-Configuring”**
  - High Quality Installation
  - Repeatable Performance
- **Up to 24 Zones**
- **Optional touch screen user interface**
- **PC-Free Setup for basic functions**
- **Simple PC interface with Windows™ based software**
- **Interfaces with Main AHU via 2H/2C Control**
- **Scheduling**
  - 2 Start/Stop Times
  - Schedule 4 Groups of Zones

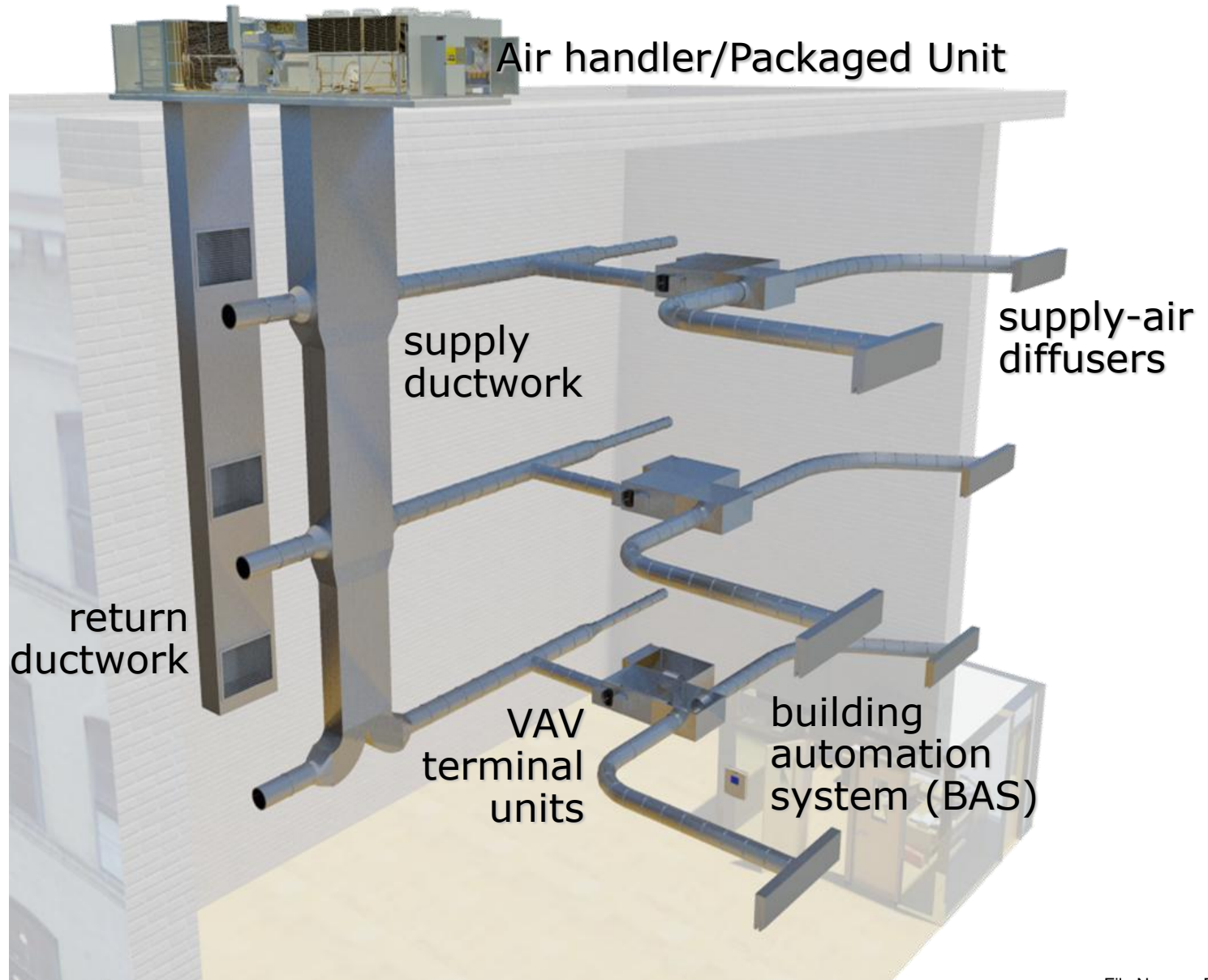


# How is changeover achieved?

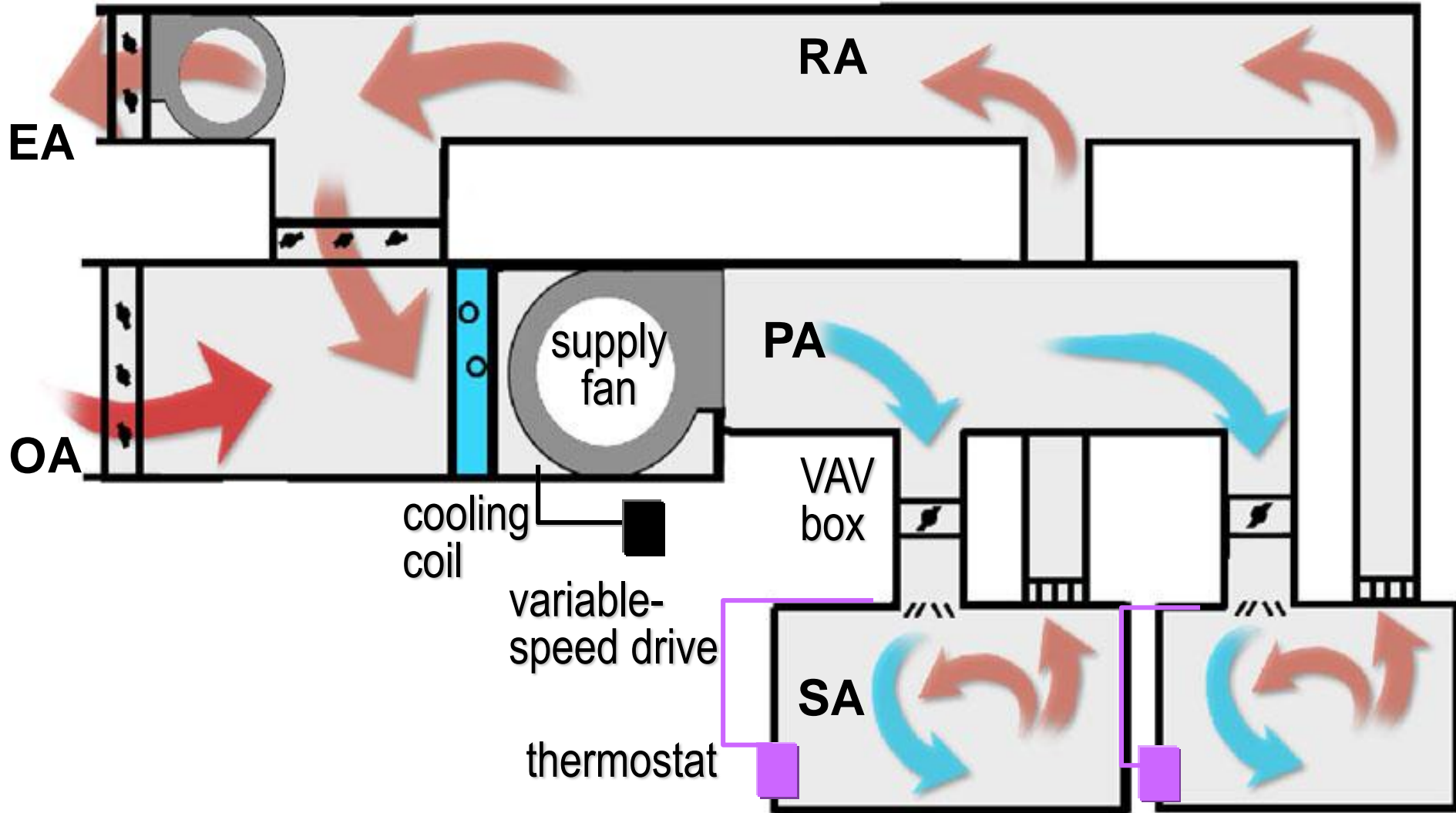
- **Voting**
  - **CCP polls UCM's**
  - **On a minimum calls for changeover the CCP will disable heat or cool and enable heat or cool**
  - **CCP then communicates to UCM's new control mode and UCM's control to different setpoints**



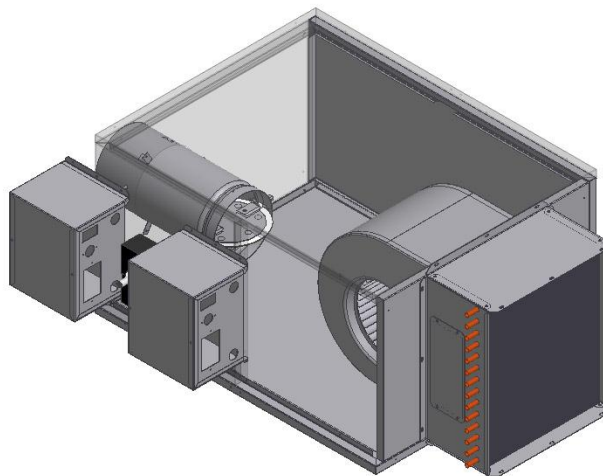
# True VAV System – (Varitrane)



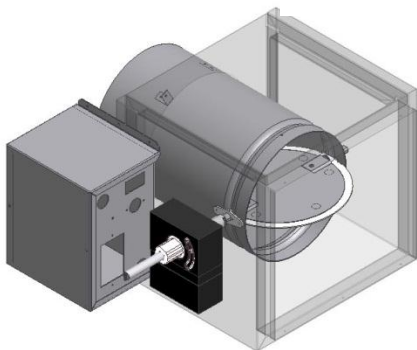
# True Variable-Air-Volume System



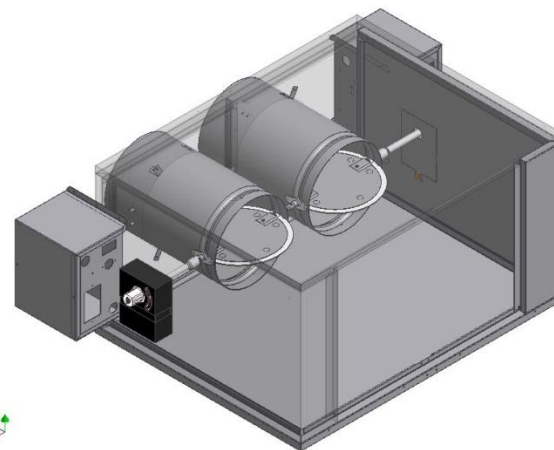
# VAV Terminal Units



Fan-powered  
VAV terminal unit



Single-duct, cooling-  
only  
VAV terminal unit



Dual-duct  
VAV terminal unit

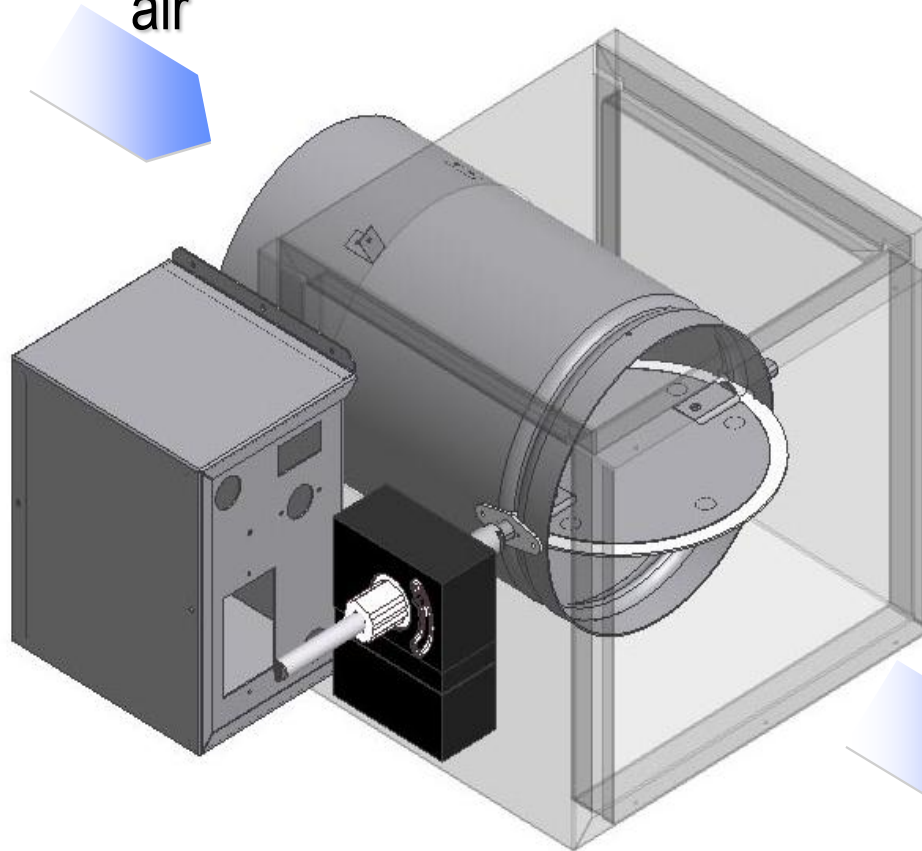
# VCCF

- **Single duct**
  - **Cooling only**
  - **No auxiliary heat**



# VCCF

primary  
air



supply  
air

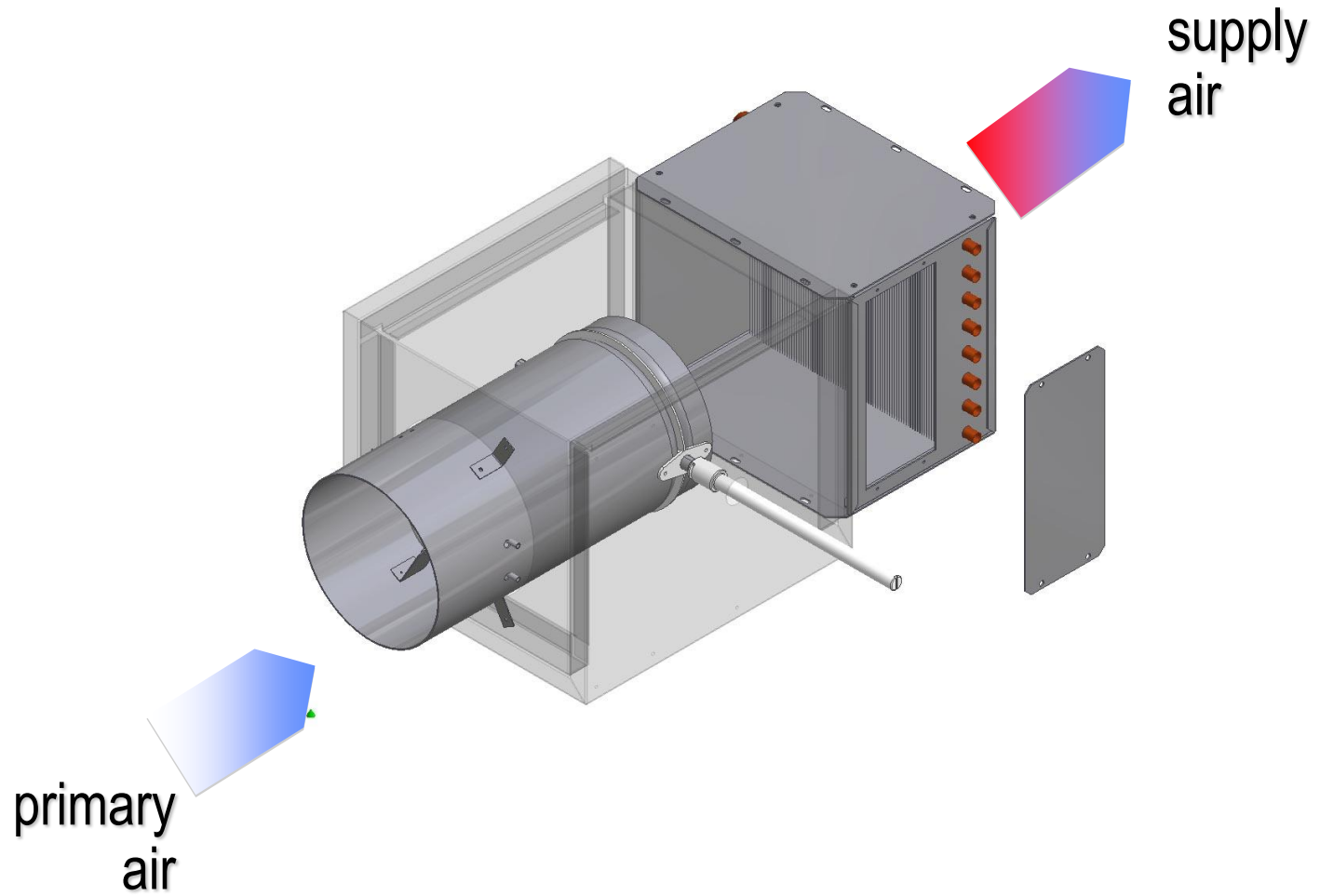


# VCWF

- **Single Duct w/hot water reheat**
  - **Hot Water Coils**
    - 1 & 2 row coils
    - Built in access panel for cleaning



# VCWF

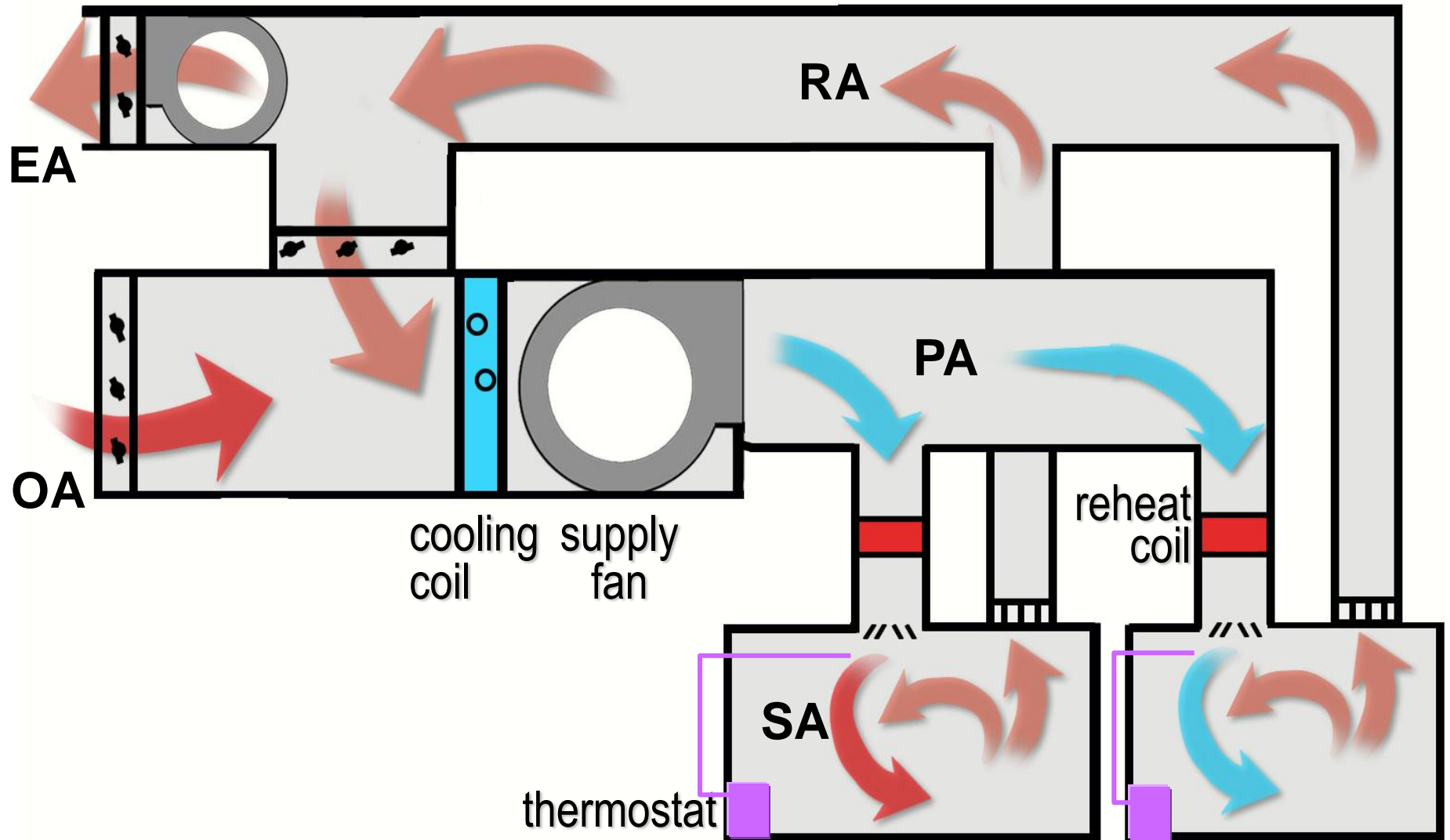


# VCEF

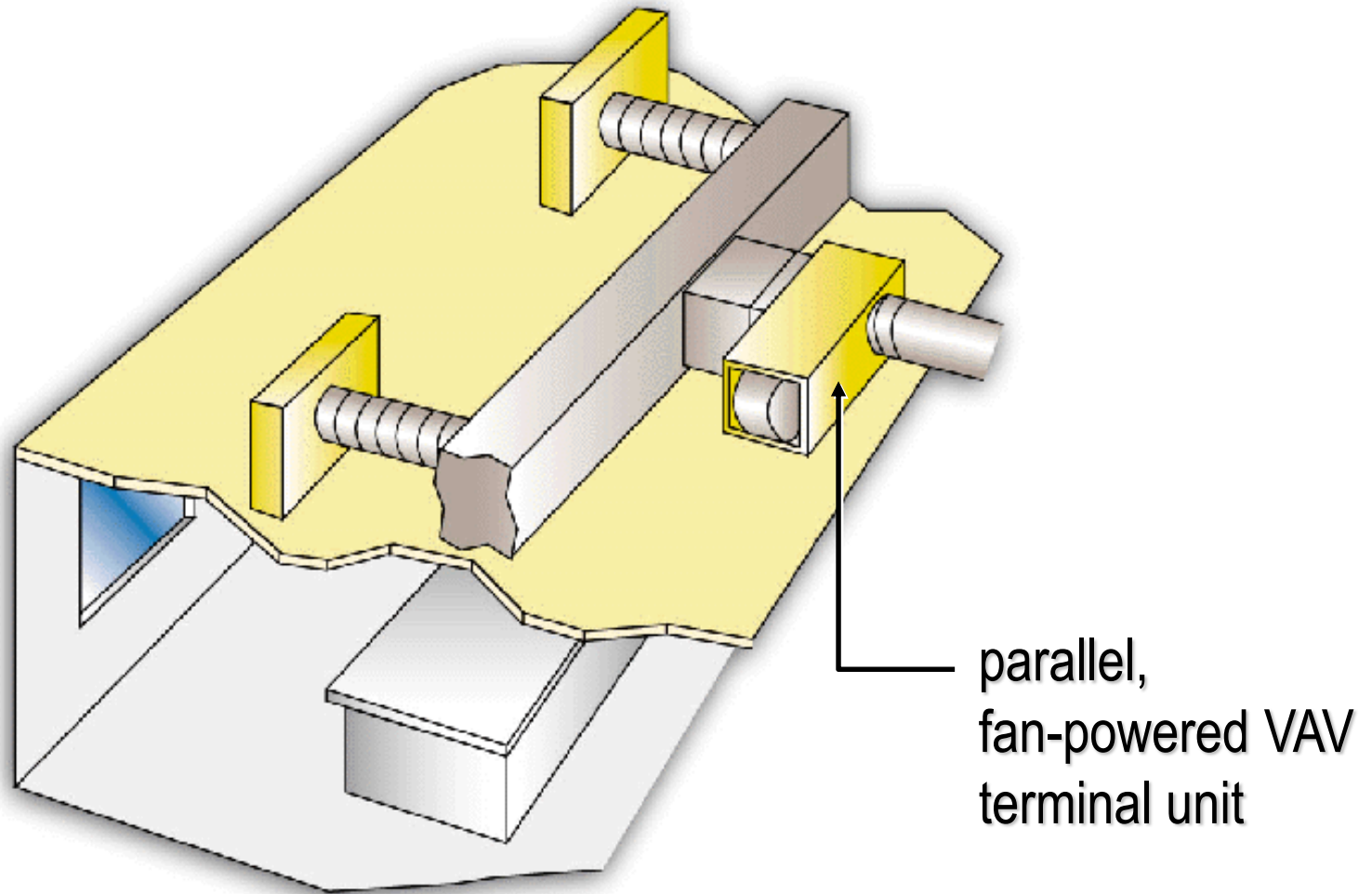
- **Single duct w/electric reheat**
  - **8 different voltages**
  - **Up to 3 stages of heat**
  - **Interlocking door disconnect**
  - **Heater line fuse**
  - **Magnetic or mercury contactors**
  - **Element removal through control enclosure**



# Terminal Reheat System

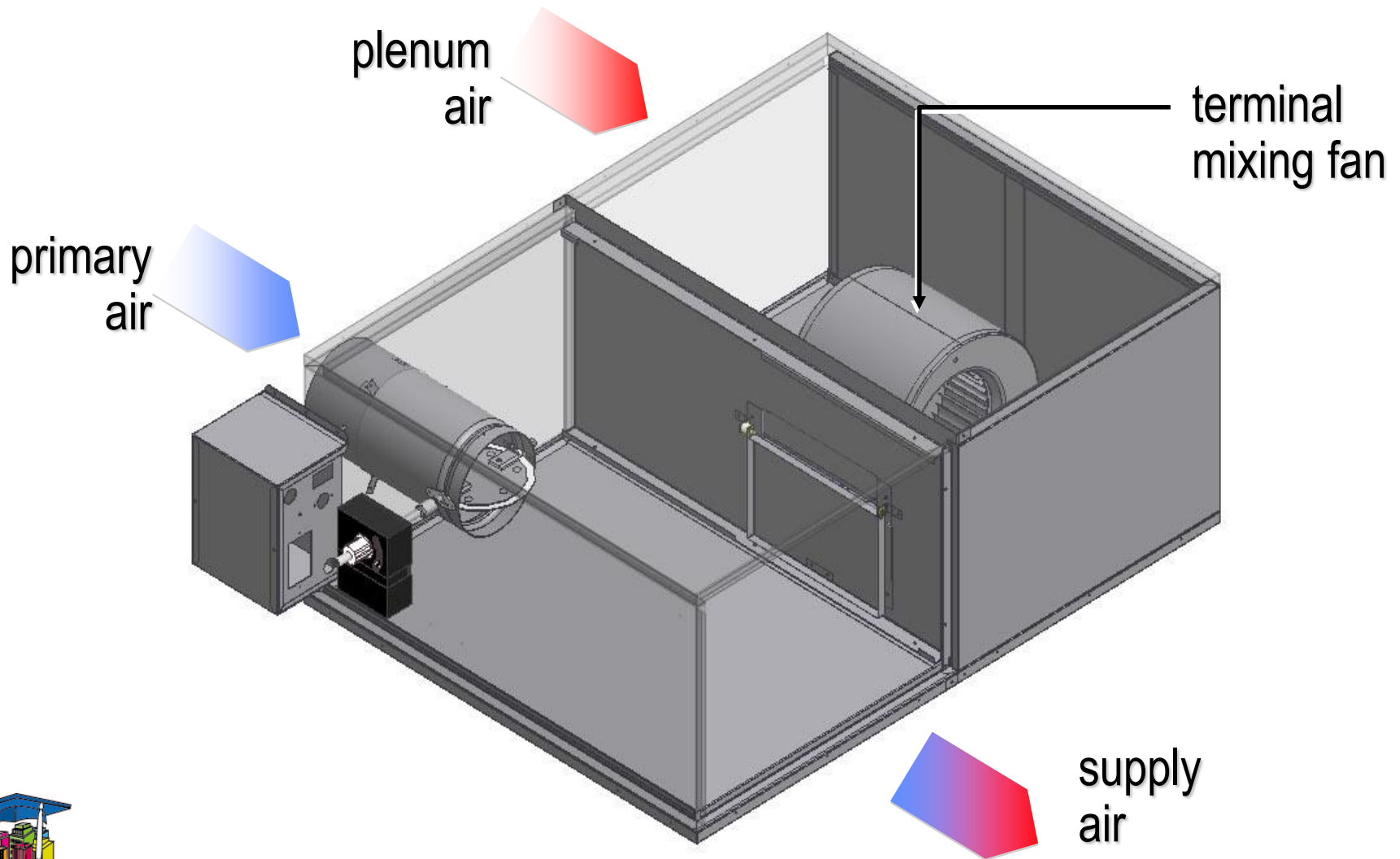


# Fan-Powered VAV

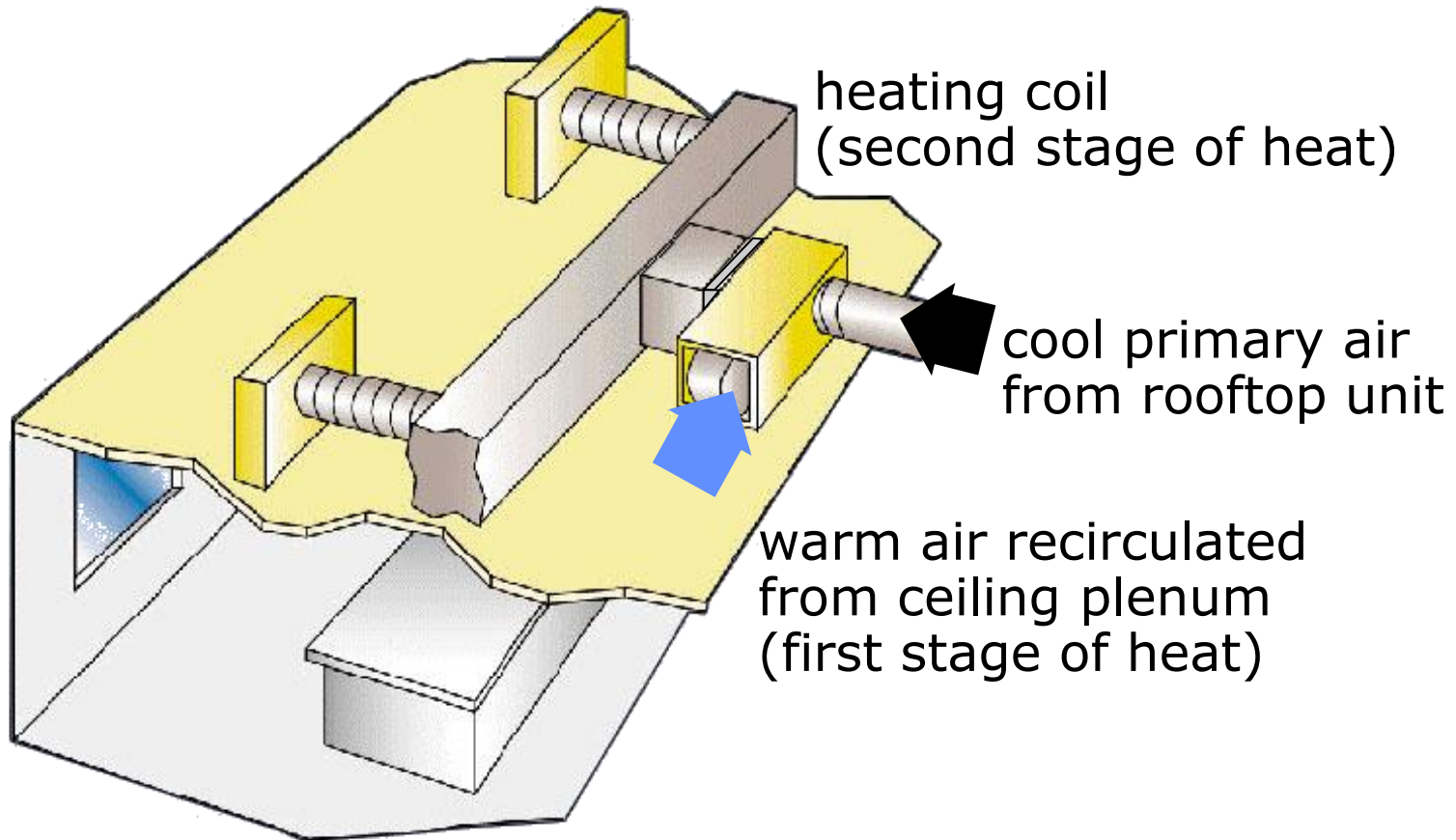


parallel,  
fan-powered VAV  
terminal unit

# Parallel, Fan-Powered

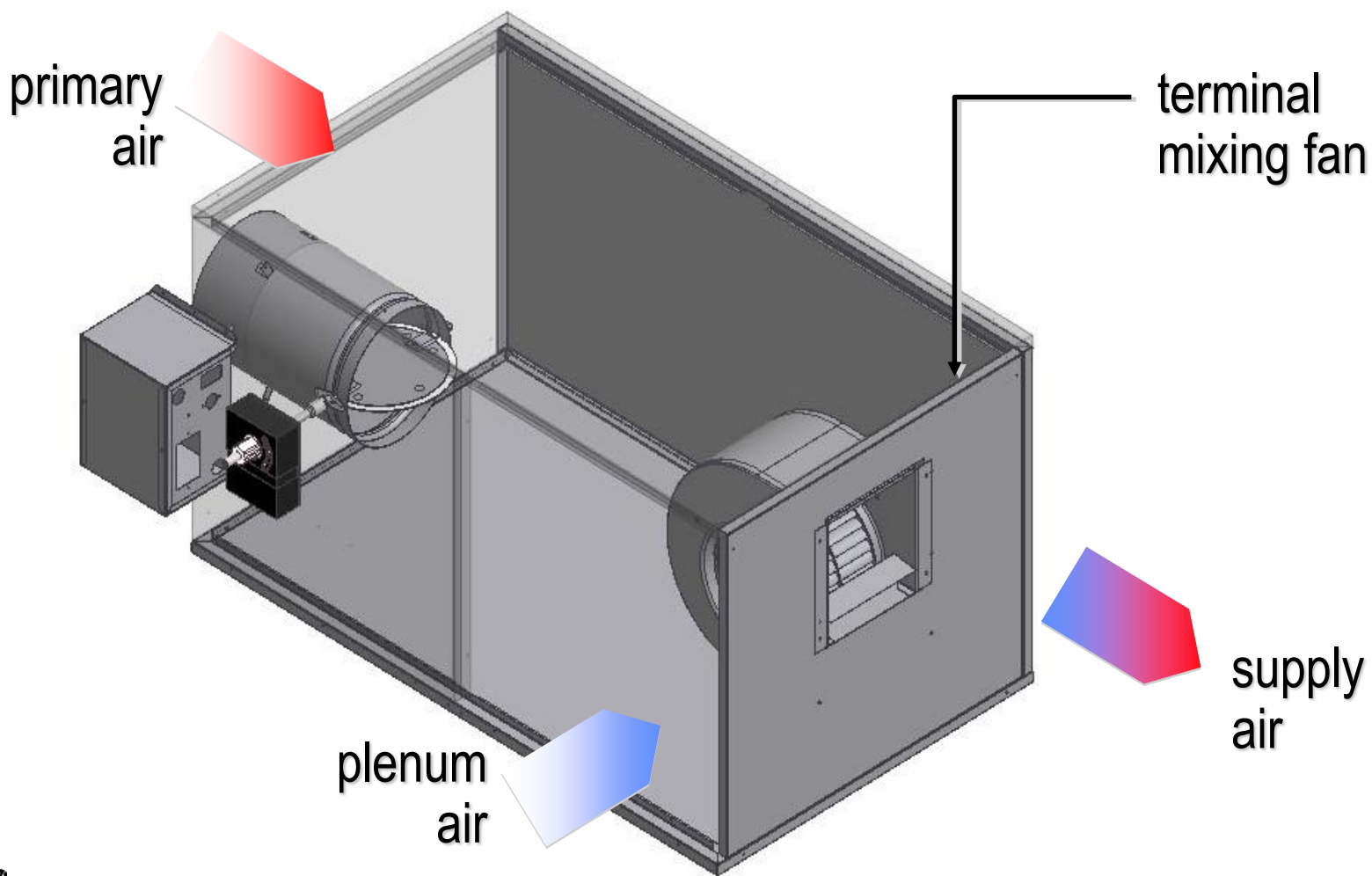


# Parallel Fan-Powered VAV



# Series, Fan-Powered

(Electrically Commutated Motors – ECM's )





# Parallel vs. Series

- **Intermittent fan**

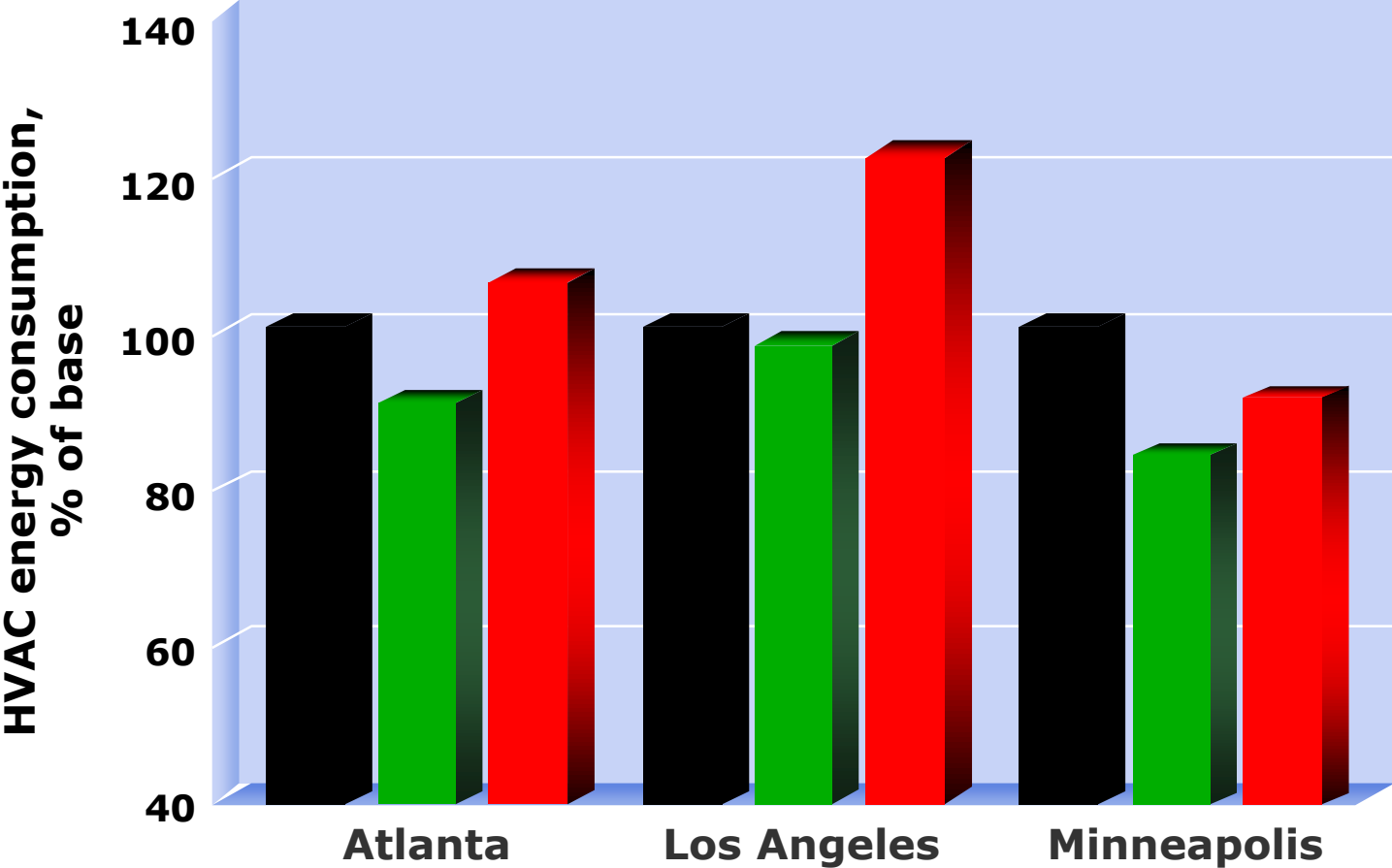
- Fan only runs in the heat mode (Variable Volume to the space)
- Fan is the first stage of heat
- Fan CFM < Max Cooling
- Most energy efficient design
- Sound in space will vary

- **Continuous fan**

- Fan runs continuously in the occupied mode (constant volume to the space)
- Fan CFM = Max Cooling
- Less energy efficient system design
- Smaller main supply fan?
- ECM Motors
- Sound remains same



*fan-powered VAV*  
**Series Versus Parallel**



**■ VAV reheat    ■ parallel FPVAV    ■ series FPVAV with ECM**



# Fan Powered Units: Cooling Only

- **Plenum Air provides “free” reheat from lights, etc.**
  - **Parallel units (only when fan energized)**
  - **Series (increases as air valve closes)**



# Fan Powered Units: Cooling with Hot Water Reheat

- **Model VPWF/LPWF (Parallel)**
  - Reheat coil mounted on plenum inlet (optional discharge)
- **Model VSWF, LSWF (Series)**
  - Reheat coil mounted on discharge
- **Coil Offerings**
  - 1 Row
  - 2 Row



# Fan Powered Units: Cooling with Electric Reheat

- **Model VPEF / LPEF(Parallel)**
  - Discharge mounted
  - UL listed



- **Model VSEF/ LSEF (Series)**
  - Discharge mounted
  - UL listed



# Fan Powered Units: Electric Heater Options

- 8 different voltages
- 2 stages of heat (plus the fan as stage 1)
- Interlocking door disconnect
- Heater line fuse
- Air flow switch
- Magnetic or mercury contactors



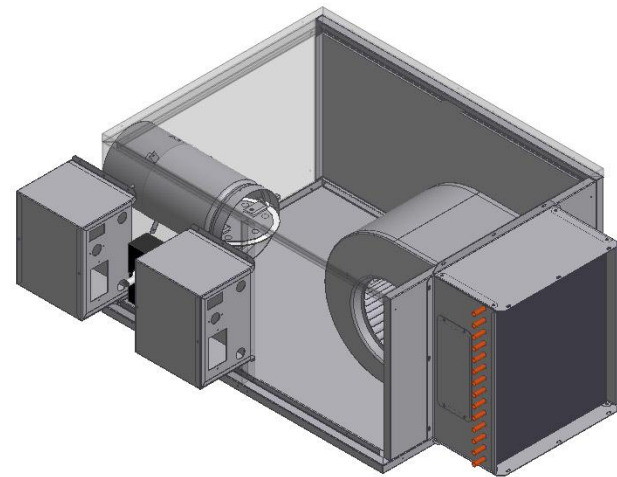
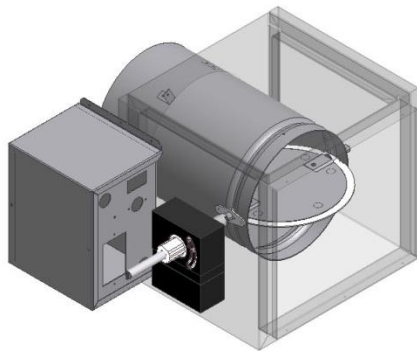
# Differences between VariTrac and VariTrane

- **VariTrac**
  - Used in **Smaller buildings** seeking cost-effective zone control
  - **Simpler System Control**
  - **Less expensive** than VariTrane
  - **Smaller Constant Volume AHU/RTU (Typically 15 tons or less)**
  - **Up to 24 zones**
  - **Pressure Dependent**
- **VariTrane**
  - Used in **Larger Buildings** **seeking ideal occupant comfort**
  - **Very Flexible System Control (more complex sequences)**
  - **Larger Variable Volume AHU/RTU equipment (up to 130 Tons)**
  - **Up to 120+ zones**
  - **30% fan energy savings over CV**
  - **Pressure Independent**



# VAV System Types

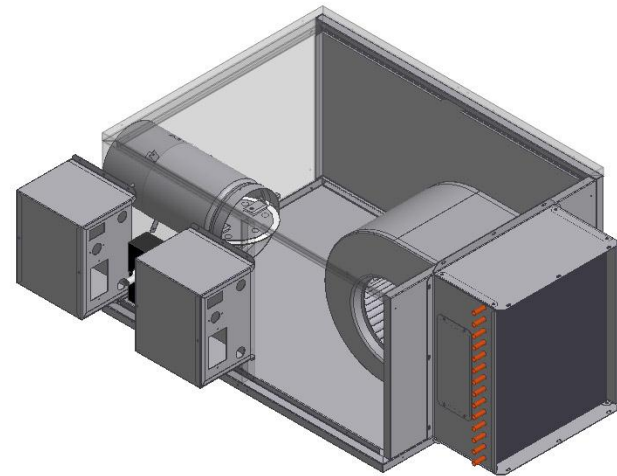
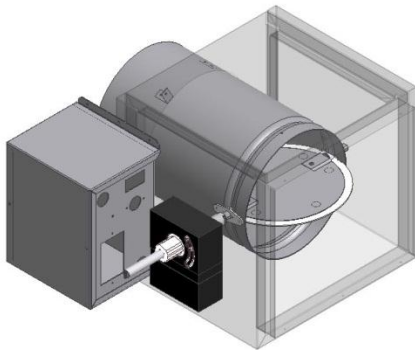
## Single Zone VAV





# Single Zone VAV

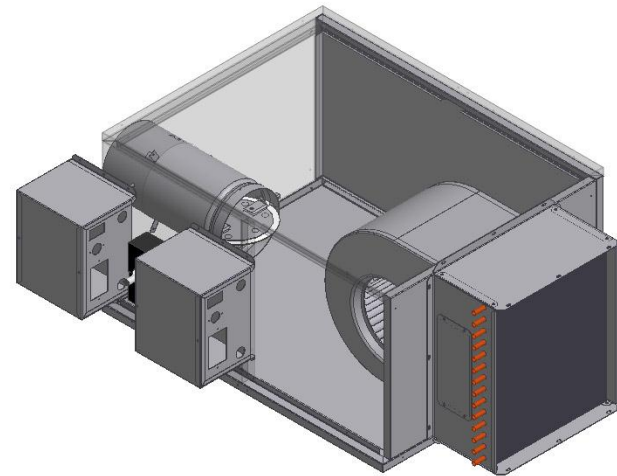
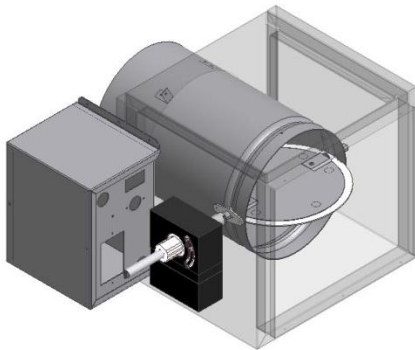
**AHU is your VAV Box !!**



# Application for Single Zone VAV

**Large areas** ( conference rooms, assembly halls...)

**Control air flow off room sensor**



# Controls

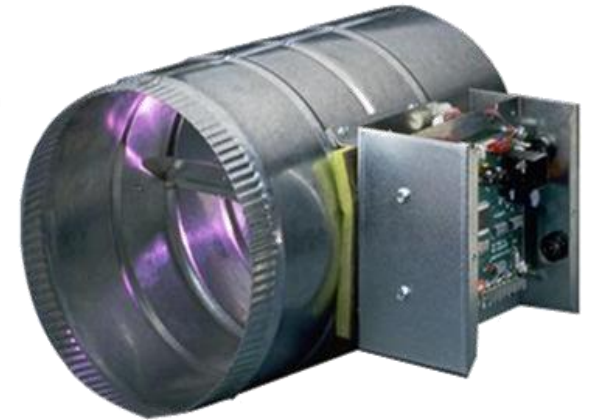
**Unit controls**



**System controls**



# Unit Controls

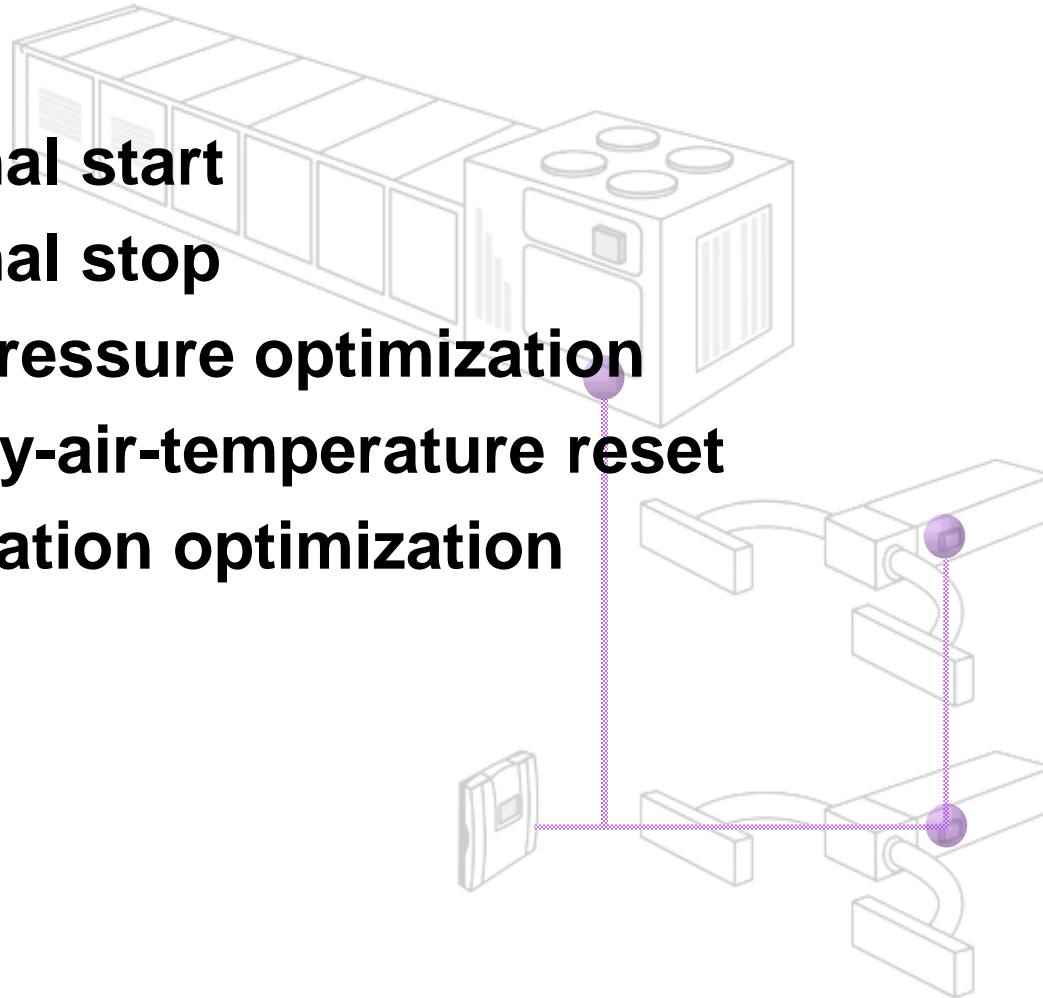


- **Pneumatic Controls - about 5% (PN\*\*)**
- **No- controls- field installation of others controllers- about 5% (ENON)**
- **Factory Installation of others Controls- about 20% (FM0\*)**
- **DDC Controls - around 70% (DD\*\*)**
  - **Trane DDC (Communicates to a Trane-Trane-Trane System)**
  - **Trane LonTalk DDC (designed to talk a language which is not proprietary to Trane)**

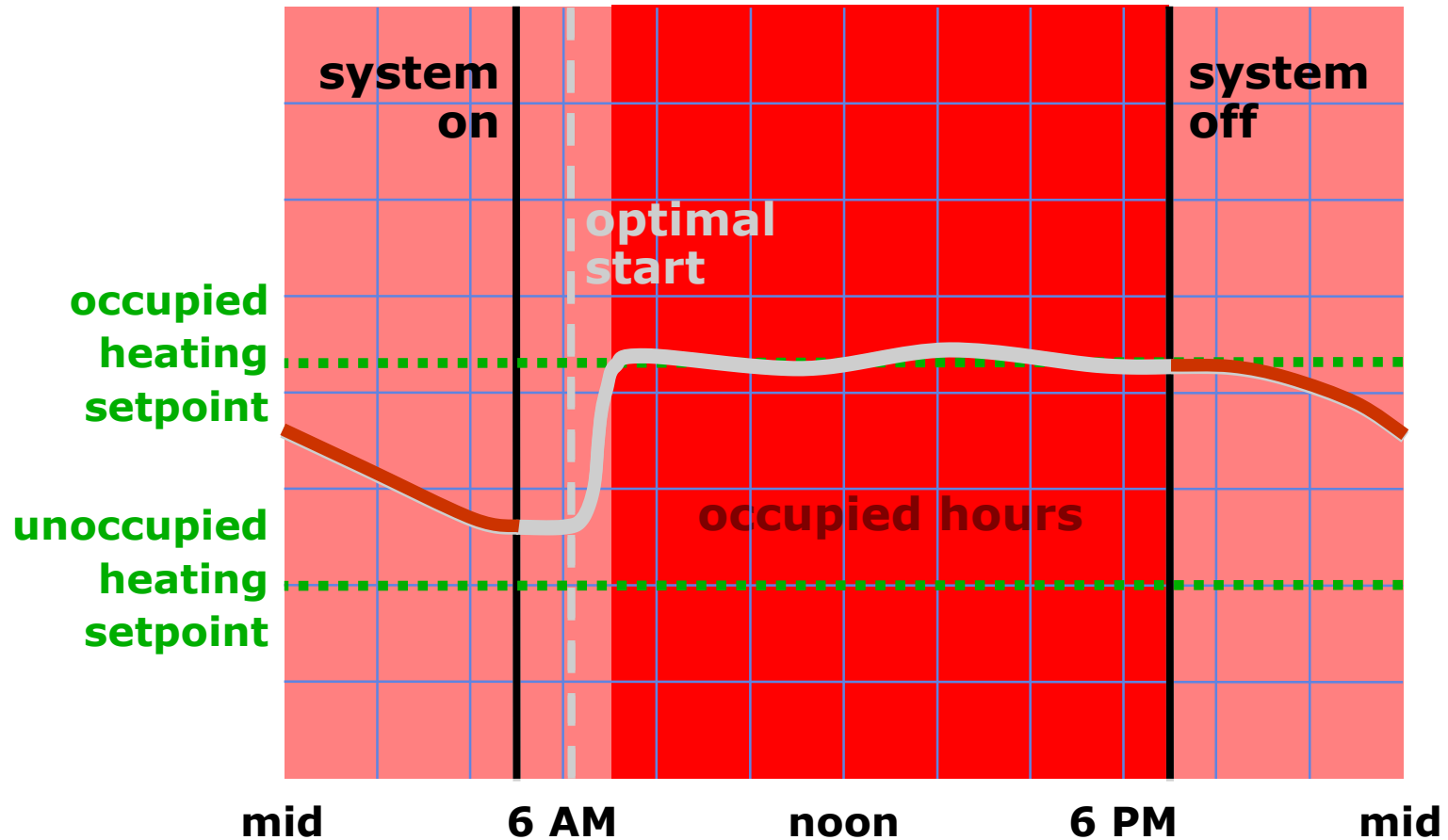
# VAV systems

## Optimized System Controls

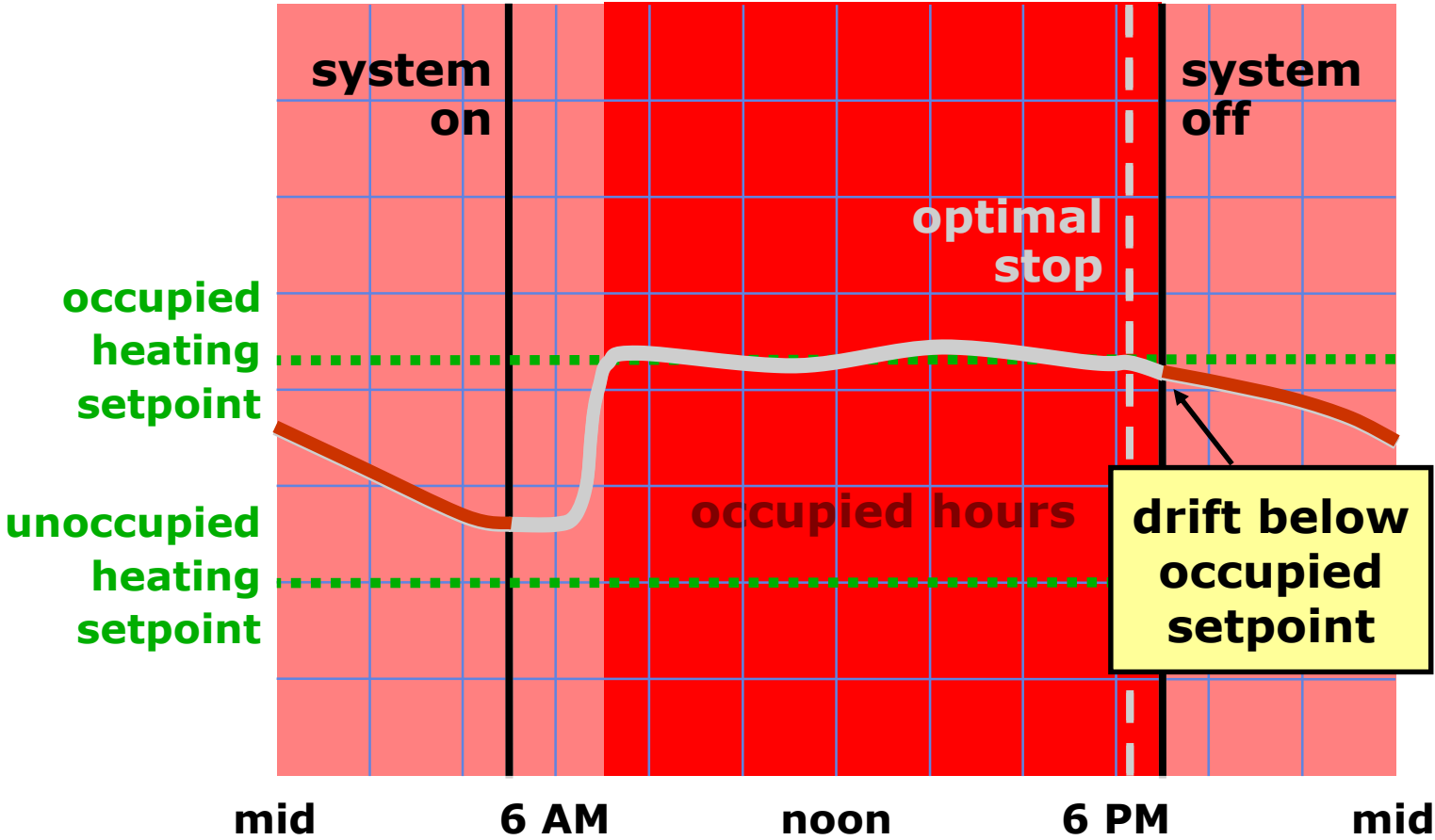
- **Optimal start**
- **Optimal stop**
- **Fan-pressure optimization**
- **Supply-air-temperature reset**
- **Ventilation optimization**



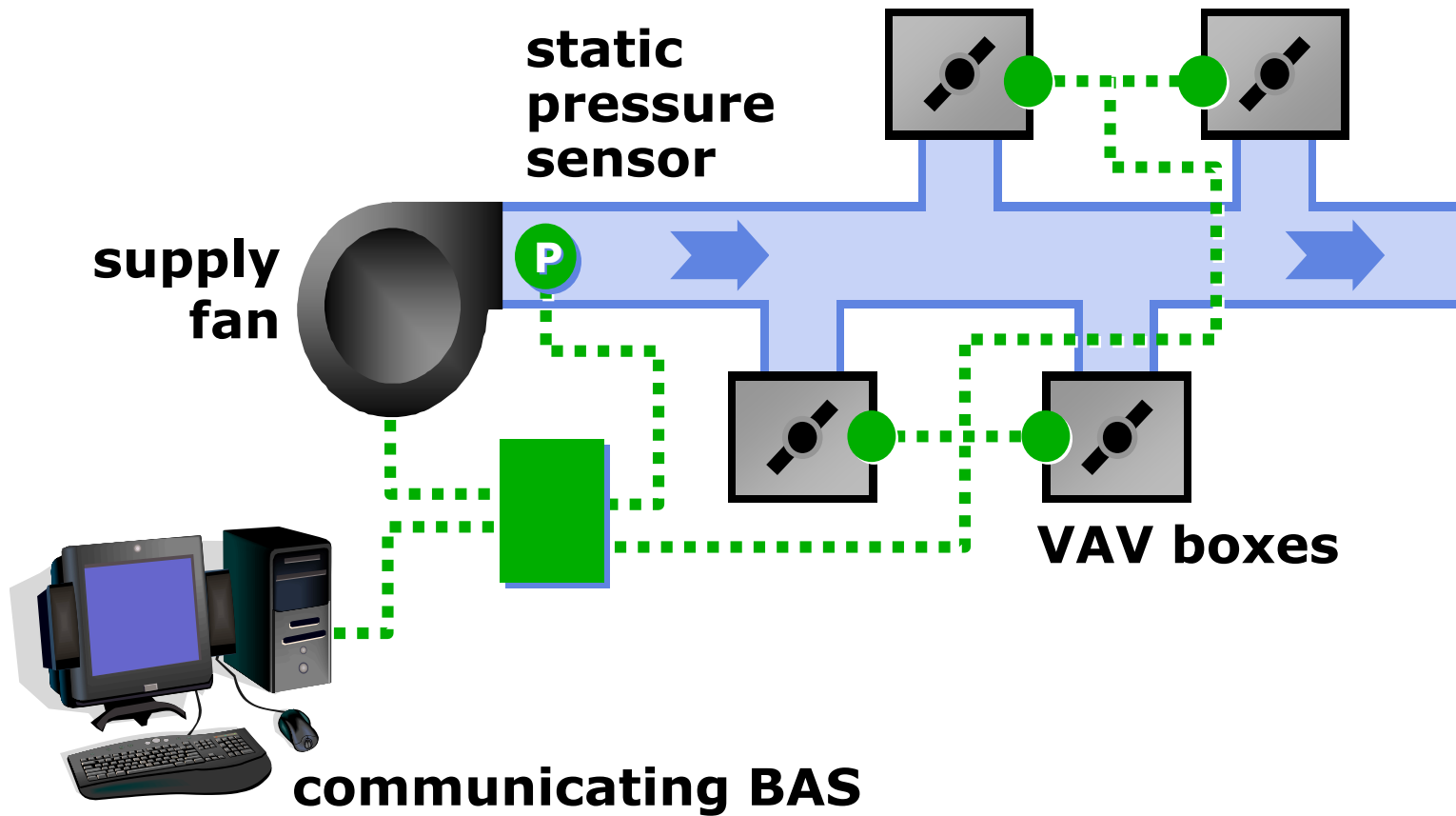
# Optimal Start



# Optimal Stop



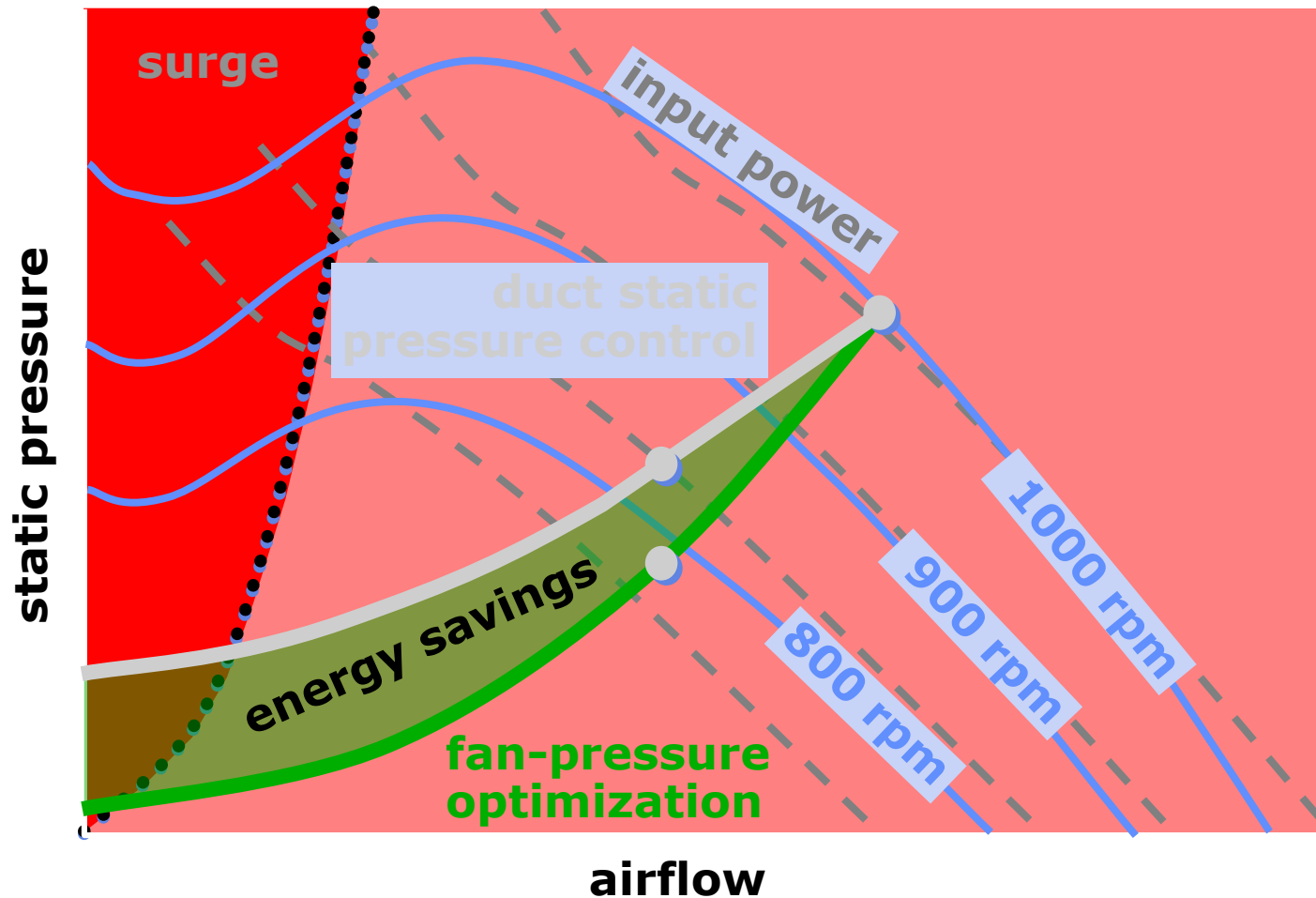
# Fan-Pressure Optimization





# fan-pressure optimization

## Part-Load Energy Savings



*ASHRAE Standard 62.1-2004*

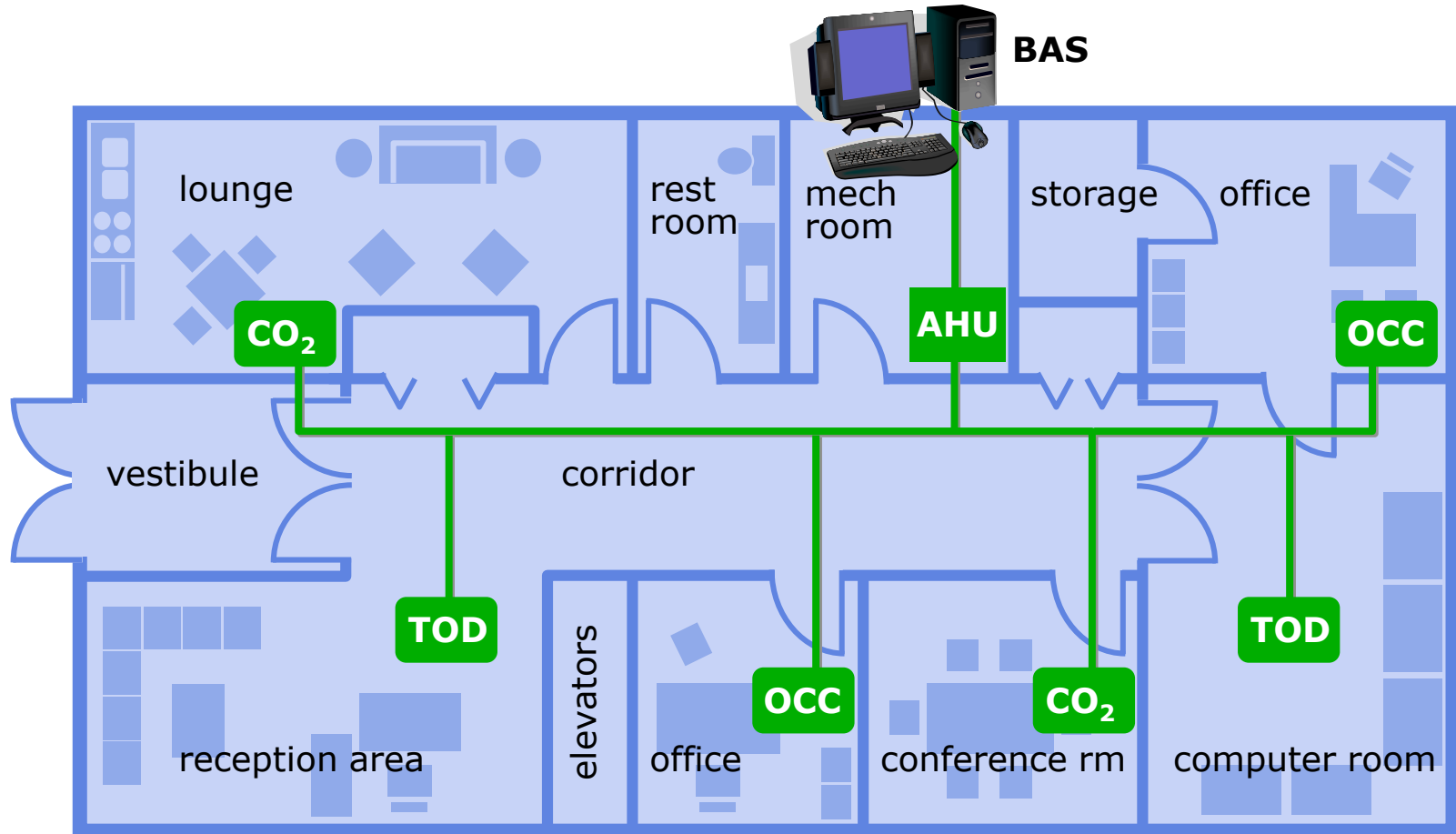
# Dynamic Reset of OA

- **May reset OA intake flow (or zone OA flow) in response to:**
  - **Variations in zone population (demand-controlled ventilation, or DCV)**
  - **Variations in ventilation efficiency due to changes in airflow (ventilation reset)**



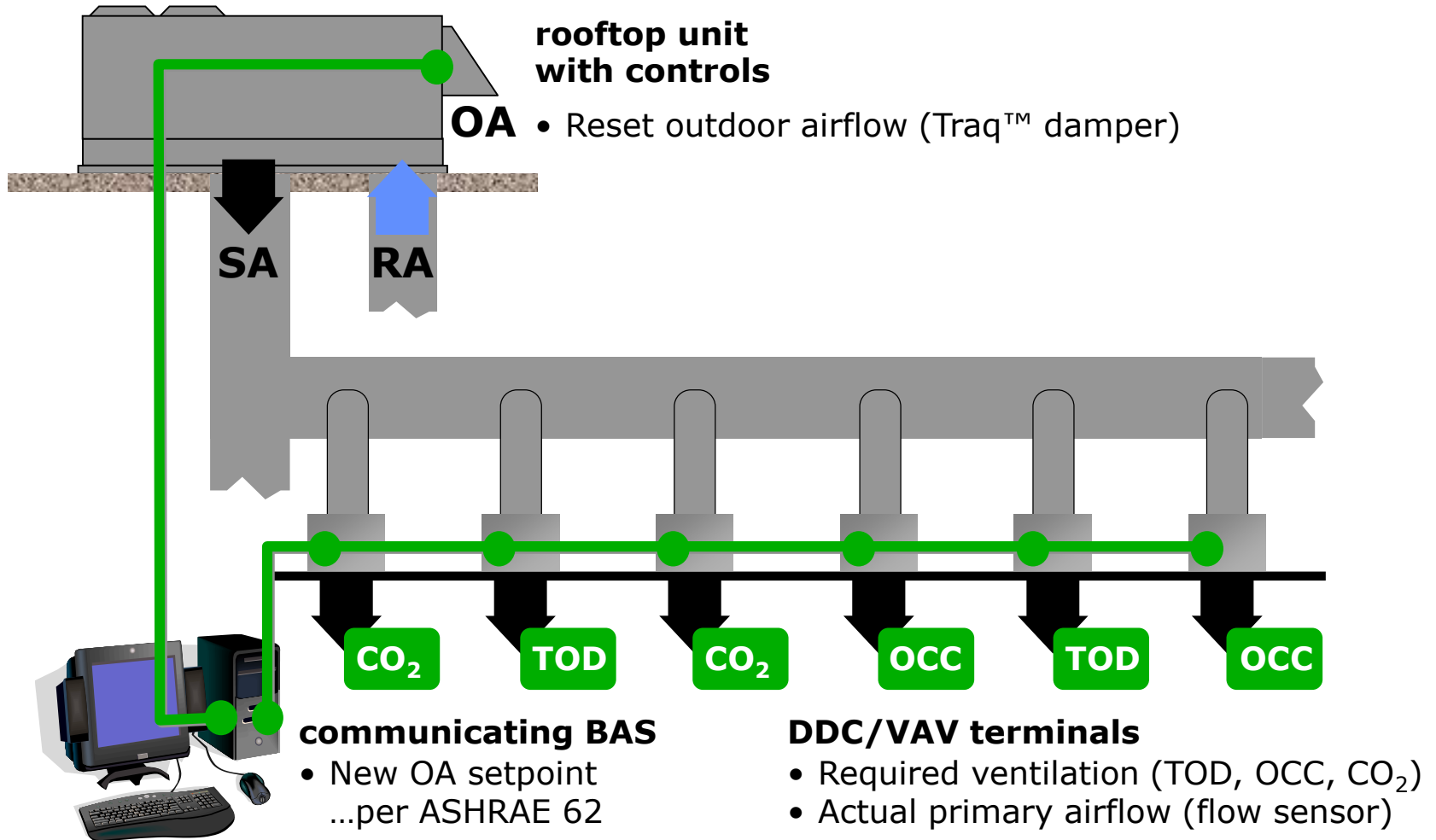
# ventilation optimization

## Zone Level: DCV

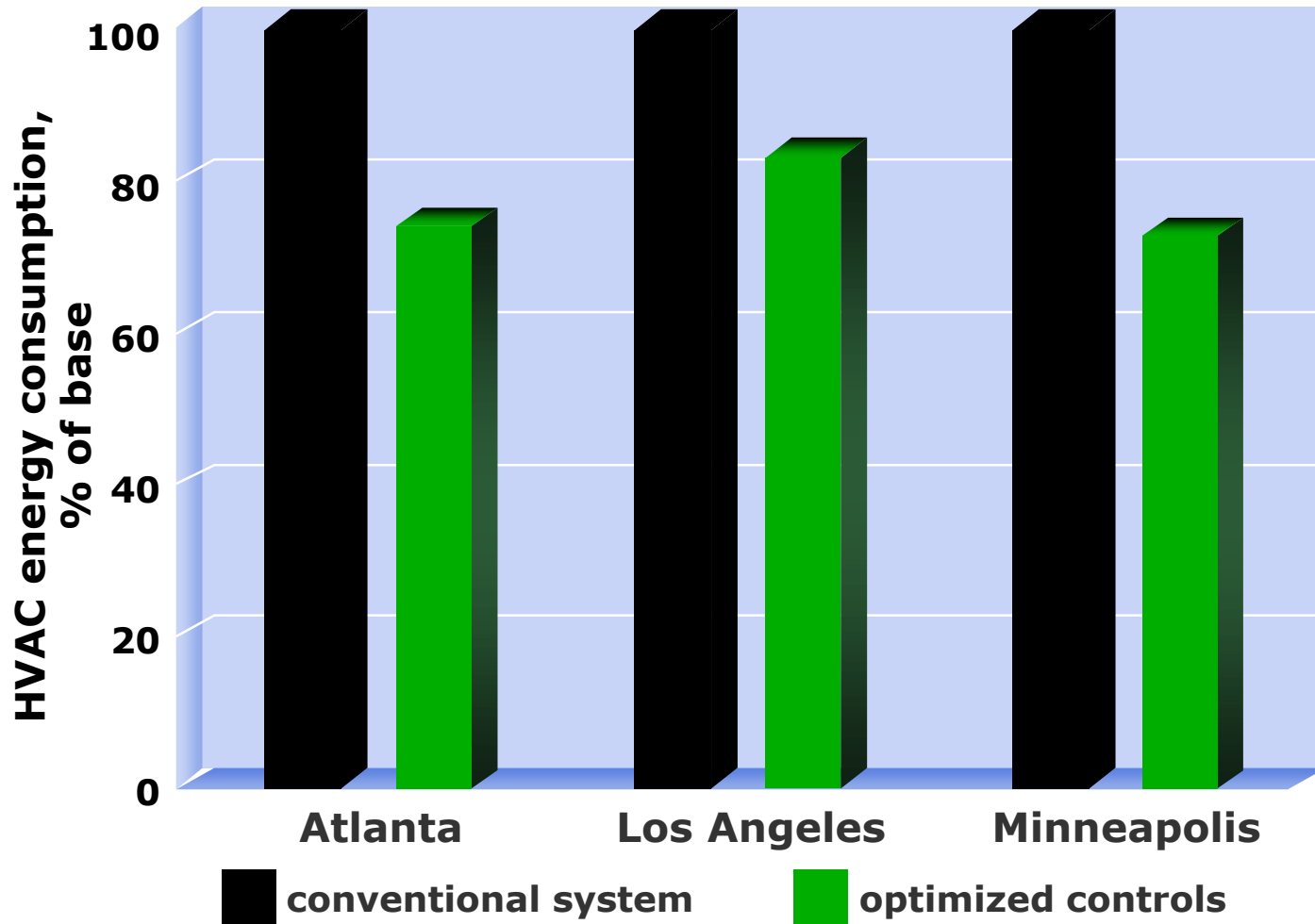


## ventilation optimization

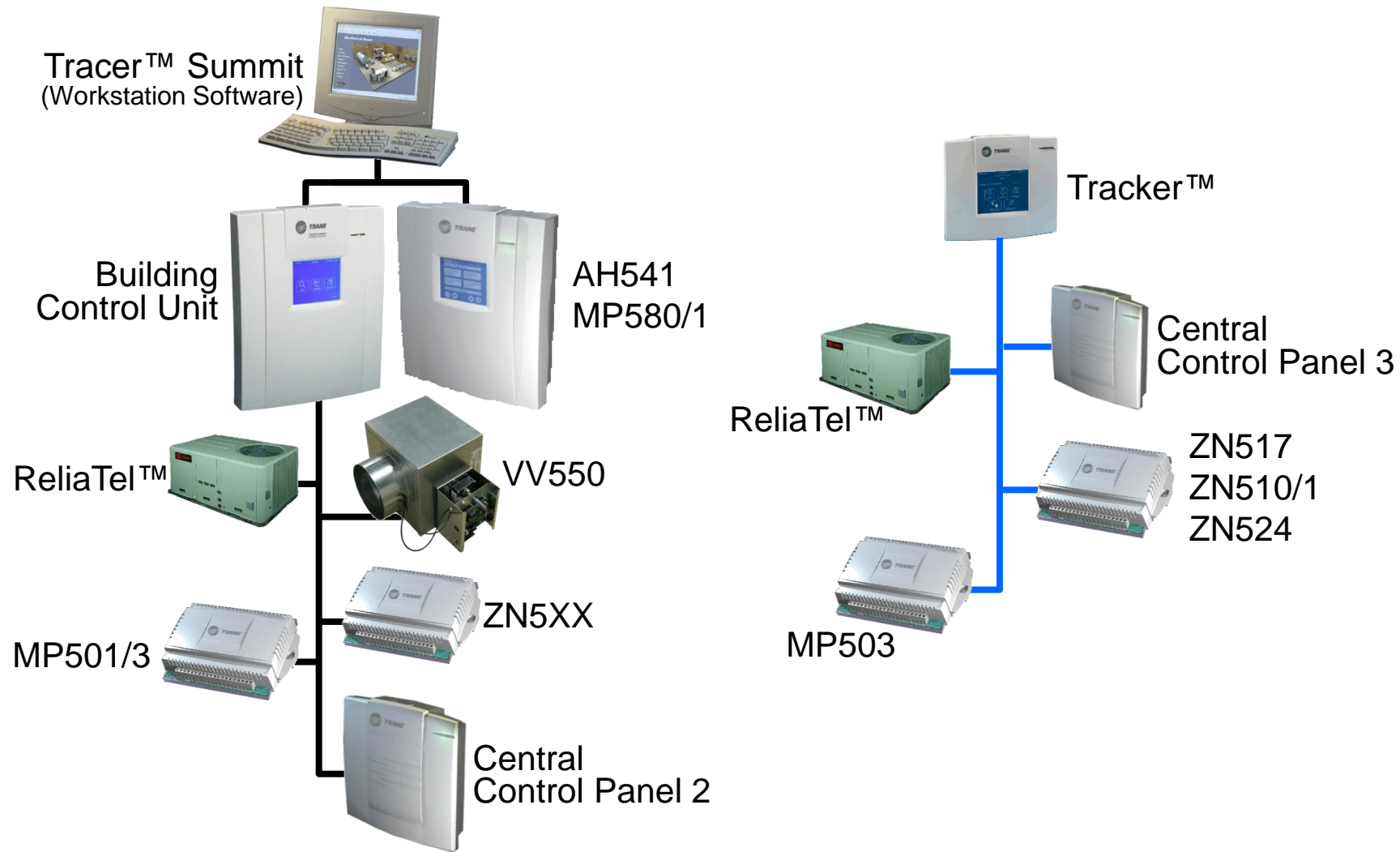
# System Level: Ventilation Reset



*rooftop VAV system*  
**HVAC Energy Savings**



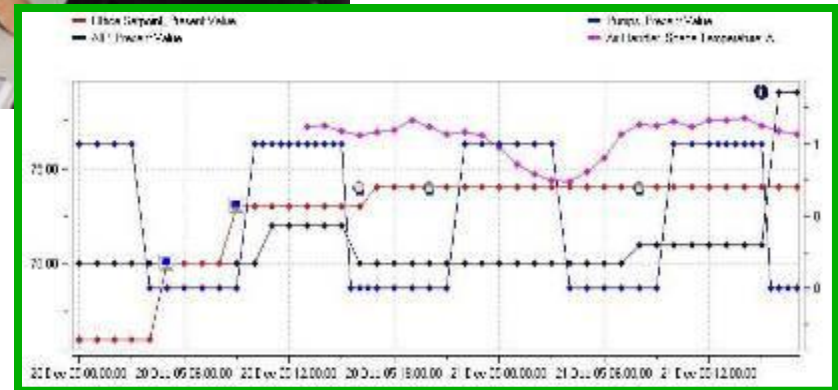
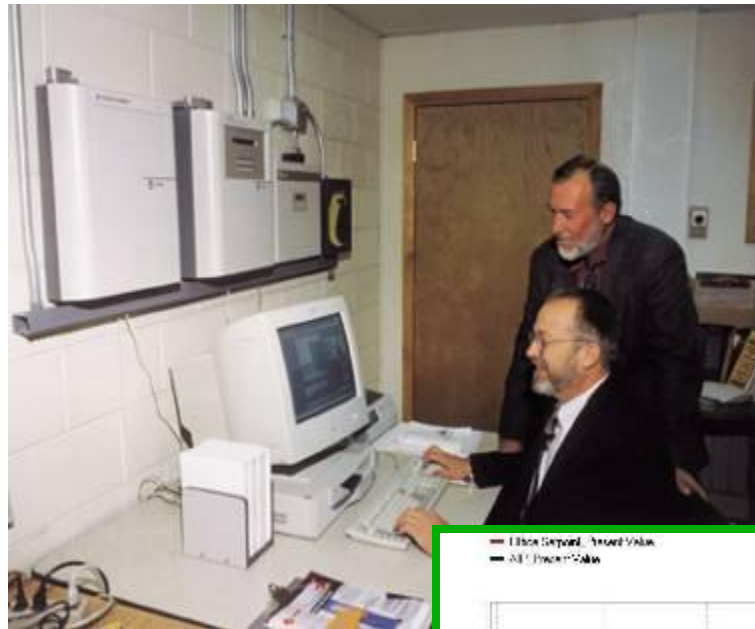
# Trane Control Systems Architecture



# VAV systems

## Sustaining Performance

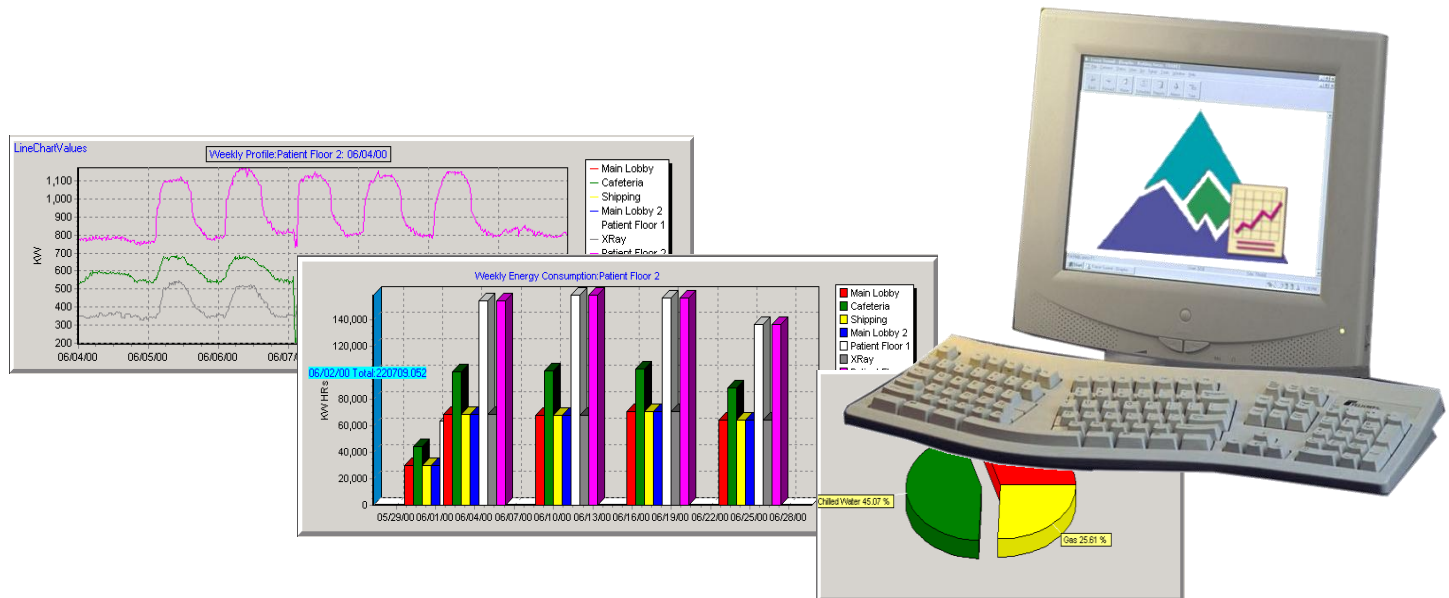
- Centralized alarming, diagnostics, trending



# VAV systems

## Sustaining Performance

- Centralized alarming, diagnostics, trending
  - Building operations, energy management, commissioning, validation

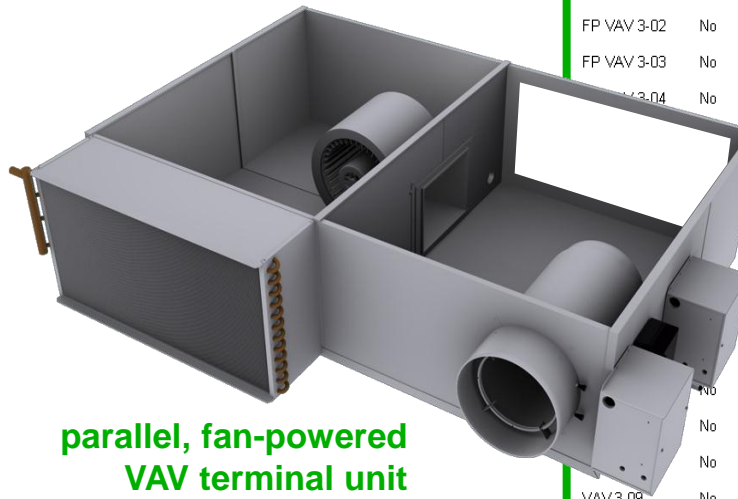




# VAV systems

## Sustaining Performance

- Centralized alarming, diagnostics, trending
- Facility management services
- **Periodic commissioning and calibration**



parallel, fan-powered  
VAV terminal unit

VAV Air System (Comm5)  
VAV Commissioning Report  
Site: Antietam

|             | Alarm Present | Zone Temp / Zone Setpt | Air Flow | Time Stamp          | 40% Flow Position | 100% Flow Position | Fan Off Temp | Fan On Temp | Reheat Off | HW Reheat | Electric Reheat 1 | Electric Reheat 2 | Electric Reheat 3 |
|-------------|---------------|------------------------|----------|---------------------|-------------------|--------------------|--------------|-------------|------------|-----------|-------------------|-------------------|-------------------|
| FP VAV 3-01 | No            | 76.6 / 73.9            | 1760     | 8/18/2003 14:37:15  | 24                | 49                 | 63           | 72          | 72         | 82.1      | ---               | ---               | ---               |
| FP VAV 3-02 | No            | 71.3 / 71.0            | 519      | 8/18/2003 14:37:15  | 24                | 45                 | 63.8         | 72.2        | 72.2       | 82.3      | ---               | ---               | ---               |
| FP VAV 3-03 | No            | 72.1 / 71.0            | 360      | 8/18/2003 14:52:15  | 35                | 72                 | 62.1         | 72.1        | 72.2       | 82.2      | ---               | ---               | ---               |
| FP VAV 3-04 | No            | 74.6 / 73.9            | 718      | 8/18/2003 14:52:15  | 37                | 90                 | 61.6         | 68.5        | 68.6       | 78.6      | ---               | ---               | ---               |
|             |               | 78 / 71.0              | 394      | 8/18/2003 14:52:15  | 39                | ---                | 64.7         | 71.6        | 71.7       | 81.7      | ---               | ---               | ---               |
|             |               | 70.6 / 71.0            | 451      | 8/18/2003 14:52:15  | 44                | ---                | 66.2         | 73.4        | 73.4       | 83.4      | ---               | ---               | ---               |
|             |               | 73.1 / 71.0            | 279      | 8/18/2003 14:52:15  | 29                | 57                 | ---          | ---         | 66.2       | 76.2      | ---               | ---               | ---               |
|             |               | 71.4 / 79.5            | 116      | 8/18/2003 15:07:15  | 21                | 69                 | ---          | ---         | 63.1       | 73.1      | ---               | ---               | ---               |
|             |               | 73.7 / 73.9            | 360      | 8/18/2003 15:07:15  | ---               | ---                | ---          | ---         | 63.6       | 73.6      | ---               | ---               | ---               |
|             |               | 73.3 / 73.9            | 339      | 8/18/2003 15:07:15  | 34                | 68                 | ---          | ---         | 63.2       | 73.2      | ---               | ---               | ---               |
|             |               | 72.4 / 71.0            | 324      | 8/18/2003 15:22:15  | 23                | 54                 | ---          | ---         | 66.5       | 76.6      | ---               | ---               | ---               |
|             | No            | 73.8 / 73.9            | 345      | 10/16/2003 15:04:08 | 31                | 61                 | ---          | ---         | 59.4       | 59.7      | ---               | ---               | ---               |
|             | No            | 74.1 / 73.9            | 644      | 8/18/2003 15:22:15  | 36                | ---                | ---          | ---         | 65.5       | 75.6      | ---               | ---               | ---               |
|             | No            | 74.4 / 73.9            | 252      | 8/18/2003 15:37:15  | 15                | 48                 | ---          | ---         | 65.6       | 75.7      | ---               | ---               | ---               |
| VAV 3-09    | No            | 73.2 / 74.6            | 275      | 10/16/2003 15:26:31 | 28                | 57                 | ---          | ---         | 60         | 60.1      | ---               | ---               | ---               |
| VAV 3-10    | No            | 71.1 / 71.0            | 241      | 8/18/2003 15:07:15  | 41                | ---                | ---          | ---         | 65.3       | 75.3      | ---               | ---               | ---               |
| VAV 3-11    | No            | 72.3 / 71.0            | 324      | 8/18/2003 15:37:15  | 34                | 99                 | ---          | ---         | 60.8       | 70.9      | ---               | ---               | ---               |
| VAV 3-12    | No            | 71.8 / 71.0            | 298      | 8/18/2003 15:52:15  | 31                | 61                 | ---          | ---         | 62         | 72        | ---               | ---               | ---               |



## VAV systems

# Sustaining Performance

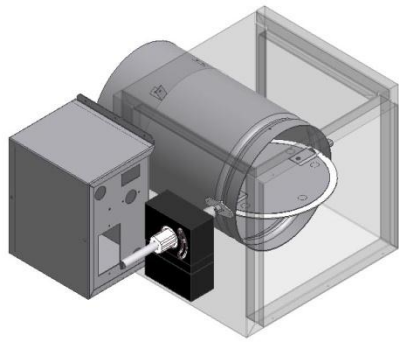
- Centralized alarming, diagnostics, trending
- Facility management services
- Periodic commissioning and calibration
- **Wireless zone sensors for flexibility**





- **EA credit 1: Optimize Energy Performance**
- **EQ credit 1: Outdoor-Air Delivery Monitoring**
- **TRACE 700 (90.1-2004, App G)**
- **Ventilation optimization in Tracer Summit**
  - **CO<sub>2</sub> sensors only in densely-occupied zones**
  - **Traq dampers in IntelliPak rooftop unit**



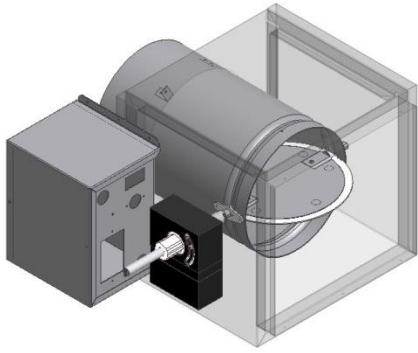


# Summary



- **What is Variable Air Volume (VAV)**
- **Why(/Not) design VAV systems**
- **What buildings utilize VAV**
- **VAV system types and their components**
  - **Changeover Bypass ( Varitrac)**
  - **True VAV ( Varitrane)**
  - **Single Zone VAV**
- **System control considerations**
- **Leed and VAV**





**QUESTIONS ??**

# ***THANK YOU***

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- **919-781-0458**

