



# Fault Detection and Diagnostics: Enabling Data Driven Building Operations with Smart Technology

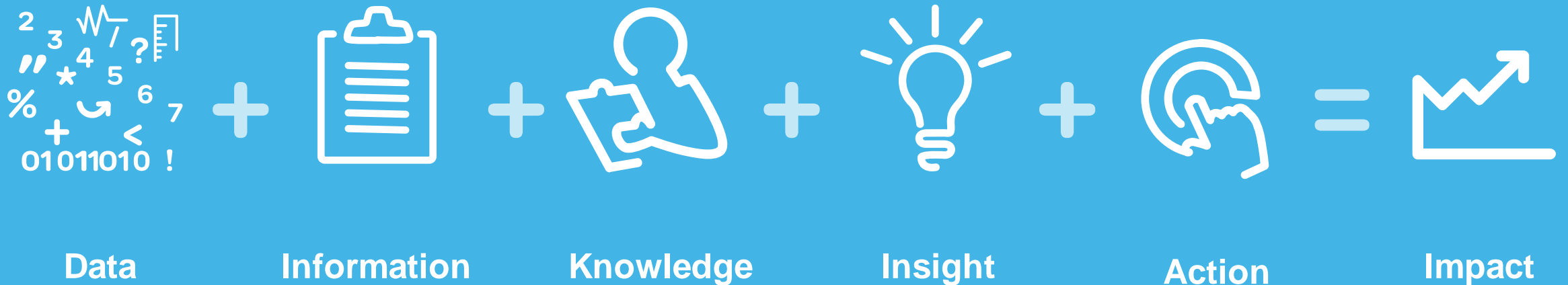
BOMA March 21, 2019

# Learning Objectives

1. Define the concept of fault detection and diagnostics (FDD)
2. Identify the major market trends driving customer need for automated building analytics/performance based analytics solutions
3. Name the outcomes and benefits of automated fault detection and diagnostics (FDD)
4. Define how automated building analytics solutions work including the systems architectures and manage services that support it
5. Describe the key components needed to specify FDD
6. Define how FDD can be leveraged for ongoing monitoring based commissioning programs
7. Identify the functionality, reporting and results available based on a demonstration of a fault detection and diagnostics tool that is currently available
8. Identify typical examples of FDD results based on 3 actual case studies

# From Data to Impact

The path to uncovering the “Aha” moments.

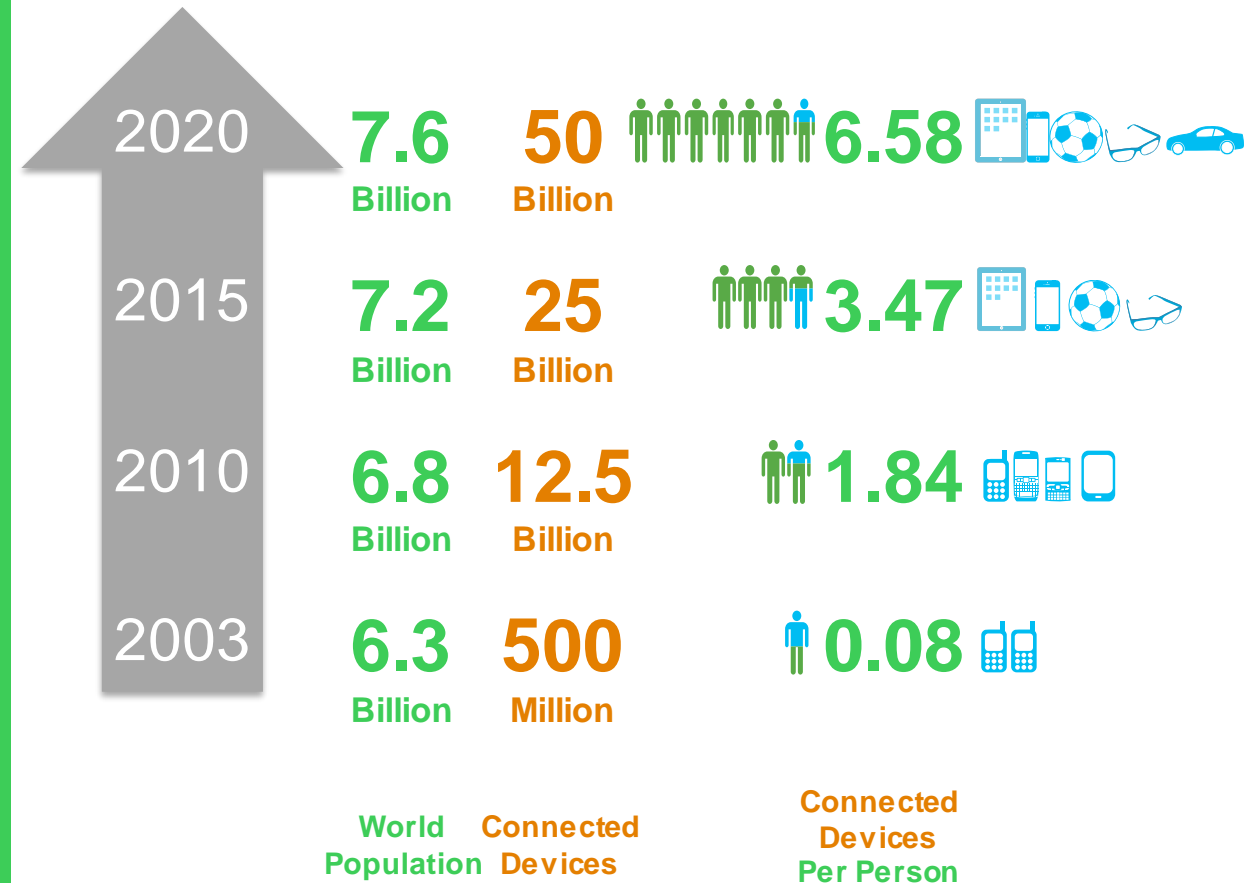


# Think about it.

The convergence of IT and OT is bringing clear tangible advantages to companies

IT-OT is creating strategic opportunities for new efficiencies across the enterprise and new procurement methodologies

Many organizations are balancing their facilities OT and IT investments



Source: Cisco IBSG, April 2011

# Change the Game

Enhance business performance

*OT delivered as a service*

A more agile, competitive enterprise

*Cost transparency; flexible infrastructure*

Reduce cost of operations and energy

*New controls in the hands of consumers*

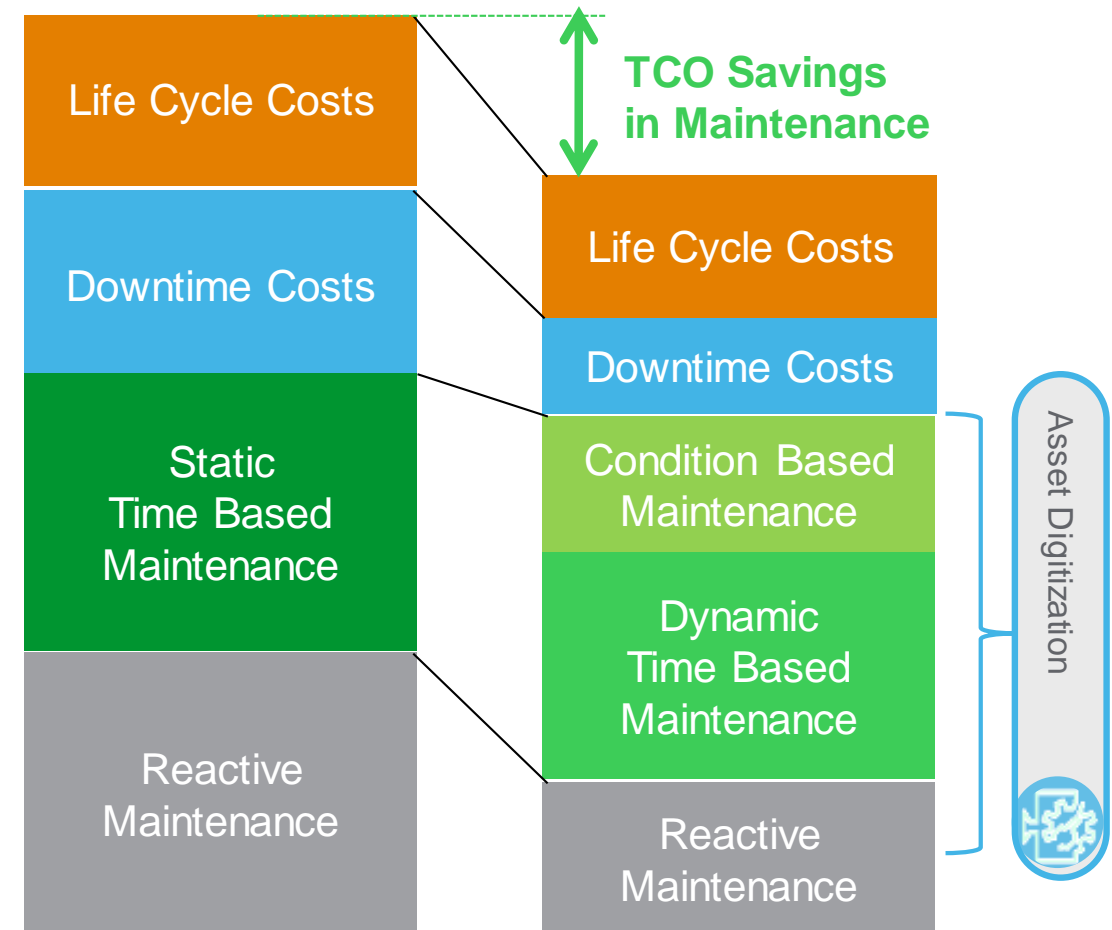
Increase enterprise security

*Integrated approach to external threats*



# Proactive Maintenance Financial Benefits

- Total Cost of Ownership -**TCO**- reduction
- Better planning for **Capex**
- **Opex** budget optimization



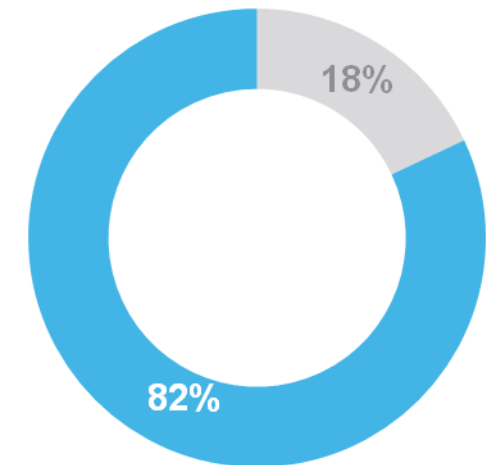
# Conditioned Based Maintenance

Evolving beyond traditional maintenance practices to leverage IOT to become predictive

- Traditional maintenance fails to address almost 80% of failures preventively.
- Use **smart assets, sensors, connectivity and FDD** to predict eminent failure and act just in time.
- Automated Fault Detection and Diagnostics (FDD)** monitors thousands of sensors, comparing actual operation against expected based on site-specific sequences to predict faults and identify better operating methods.
- BEST PRACTICE:** Utilizing FDD and conditioned-based maintenance within service plans maximizes the impact of service maintenance spend.

Failure patterns

■ Age related failure ■ Random failure



ARC studies show only 18% of asset failure is age related. Based on these data, preventive maintenance provides a benefit for just 18 percent of assets, and monitoring for Predictive maintenance is recommended option for the rest

<http://www.arcweb.com/Lists/Posts/Post.aspx?ID=260>

# FDD for Sustainability is...

...turning big data into actionable insight.

...continuous commissioning through analysis of trends, patterns and changes in the data.

...dashboards that suggest useful information while requiring little understanding or manipulation of the underlying data.

...finding faults where no alarms exist



# Critical facility management drivers are impacting all industries

Sustainability

New technology

Labor conditions

Aging facilities

Risk management

Outsourcing





# Daily challenges

- Occupant comfort
- Complex building systems
- Shortage of personnel and operator training
- Minimal available budget
- Not all buildings and systems deliver on their capabilities
- Need for ROI-justified decision making

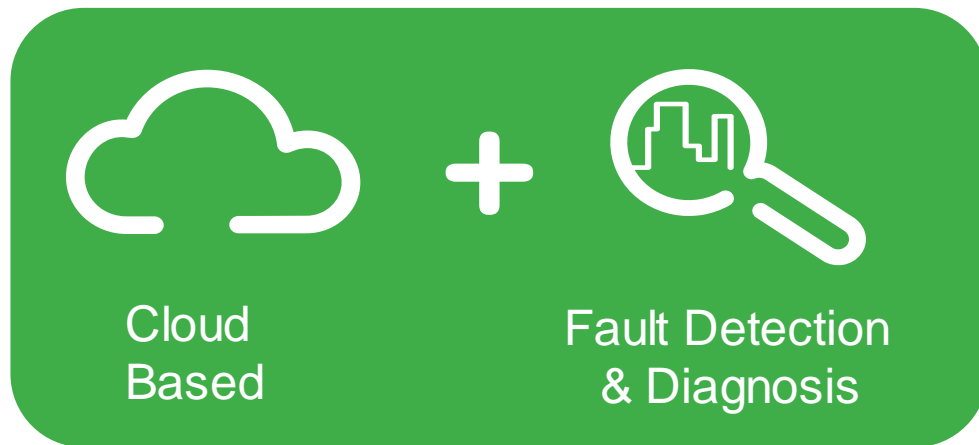


***Actionable information is required – not just lots of building data...***

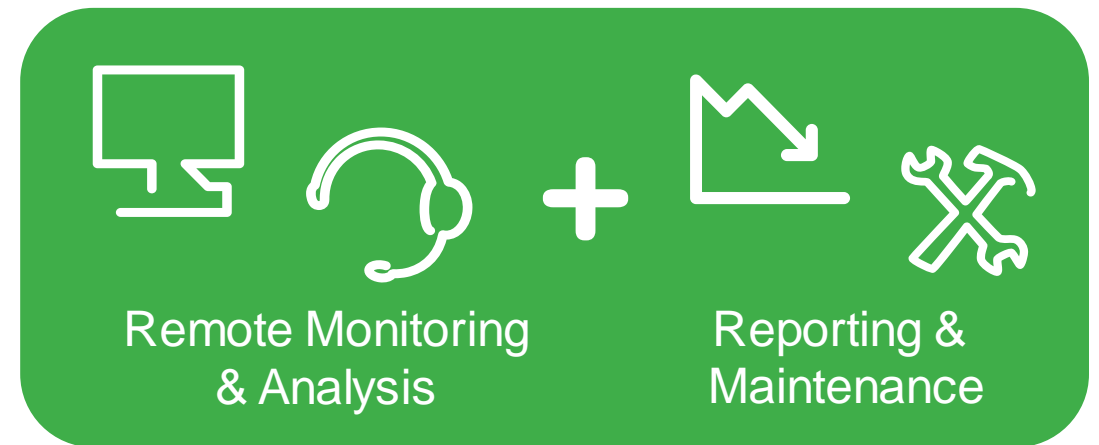
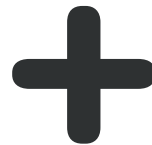
# FDD Analytics

A managed service that provides ...

- Prioritized asset optimization recommendations
- Expert guidance with actionable information
- Results that improve occupant comfort and building energy and financial well-being
- Based on statistical analysis, expert review, performance trending, and diagnostics



**Software**



**Services**

Life Is On

**Schneider**  
Electric

# What can it find?

**Looks at individual equipment and whole systems to identify faults and opportunities for improvement**



## Example of findings...

- *Simultaneous heating and cooling*
- *Manual overrides*
- *Excess reheating*
- *Trends in chiller efficiency*
- *Short cycling*
- *Leaking valves, broken dampers*
- *Opportunity for higher/lower loop setpoints*
- *Opportunity for static pressure reset*
- *Suboptimal economizer controls*
- *Poor occupancy scheduling*
- *Excessive zone temperature setpoints*
- *Recurring alarms*
- *Duration of alarms*
- *+ Custom analytics*

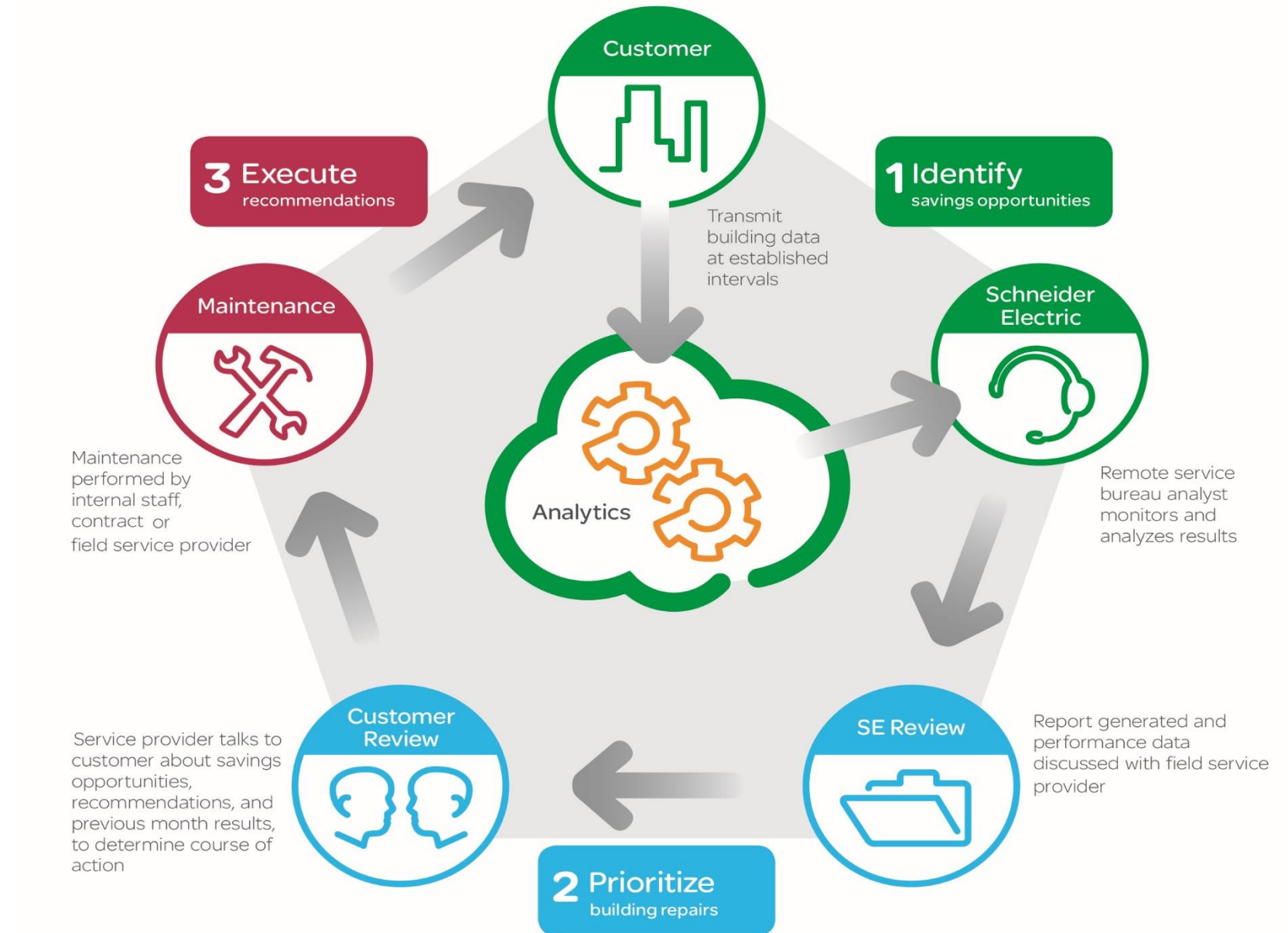
# Example of fault detection and diagnosis output (simplified)

Building	Cluster	Equipment	Fault & Diagnosis	Priority	Est. Savings*
Building 58	Cluster E	AHU-012	Leaking chilled water valve	High	\$11,291
Building 58	Cluster E	AHU-003	Damper position fault	High	\$4,782
Building 58	Cluster E	VAV-022	Over cooling	High	\$2,235
Building 58	Cluster E	CHI-002	Changes to set points	Medium	\$895

*\* Estimated savings potential, expressed an annual cost of wasted energy if not fixed.*

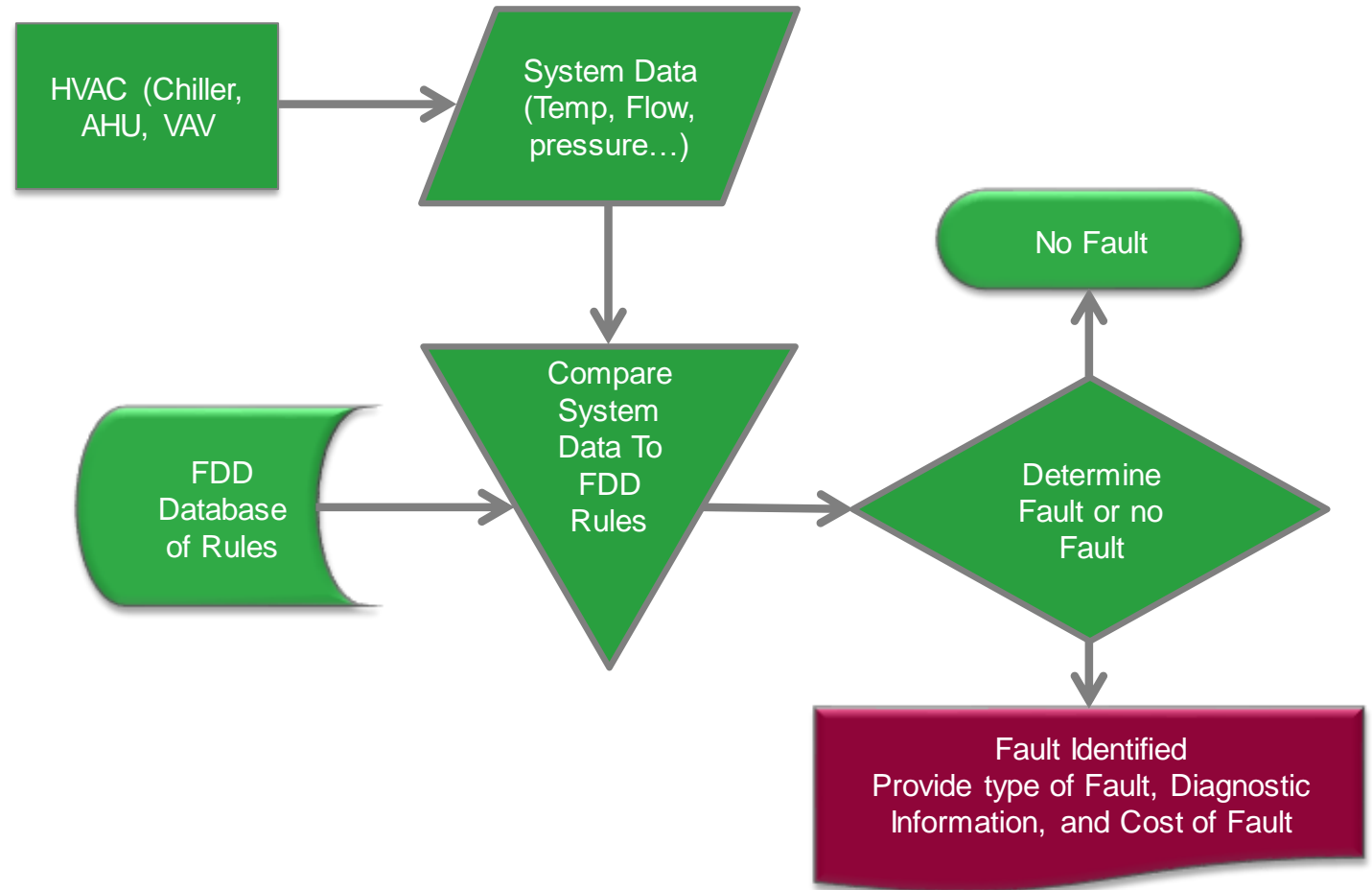
# How does it work?

Monitor, detect, diagnose,  
and identify energy  
savings opportunities



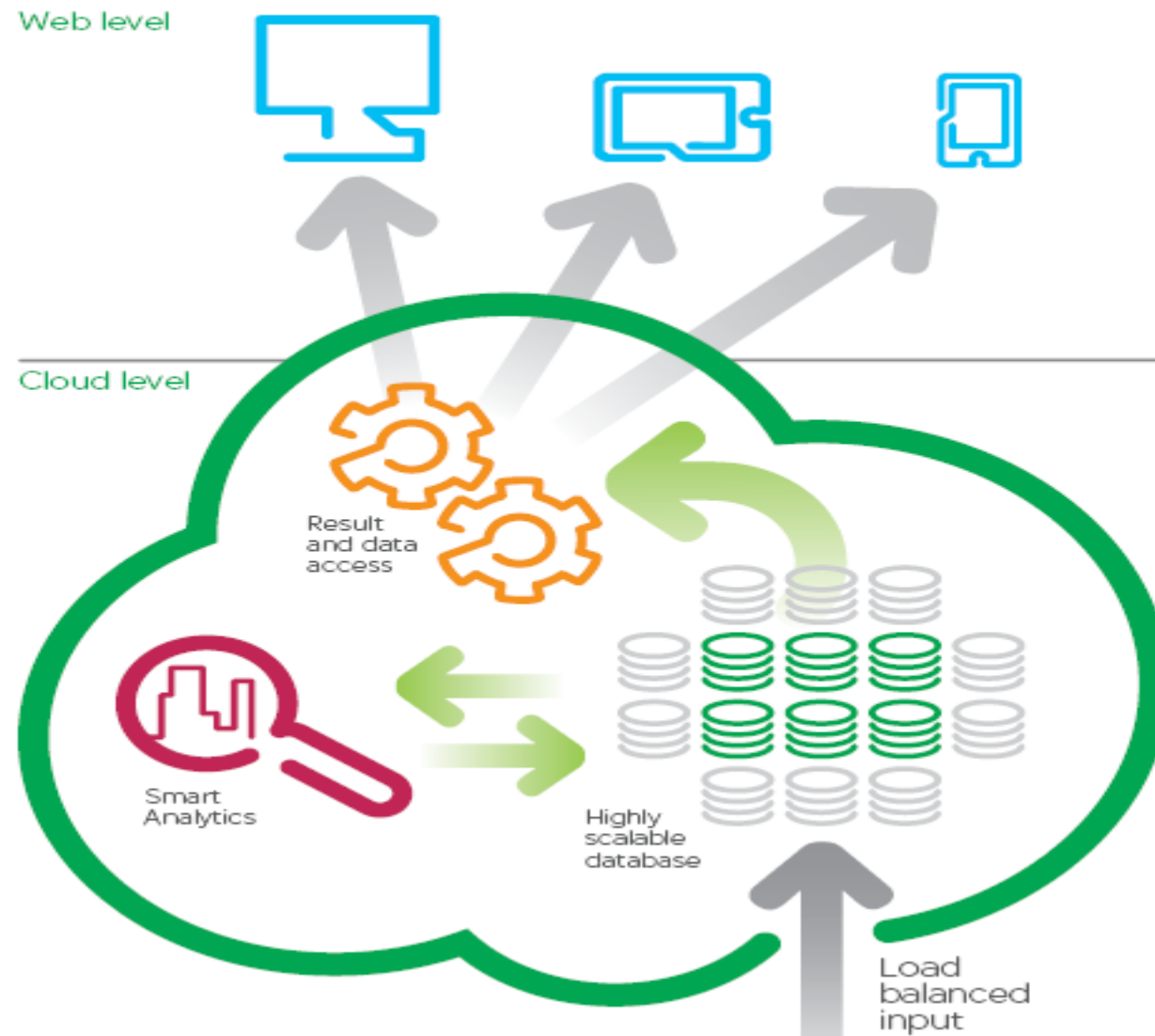
# Proactive and Preventative Maintenance

- Analytics aren't alarms. Analytics aren't reports. **Analytics are results** – specific findings of operational issues presented to the user in clear understandable views – views that tell us exactly what the issue is, when it occurred, how long it lasted, the status of all related operating conditions, and even the cost impact of the issue.
- Analytics enables you to find patterns and issues you weren't aware of – patterns that you didn't expect or couldn't have imagined. Analytics provide results that show **how your building systems really operate versus how you thought they were operating**.





# System architecture breakdown

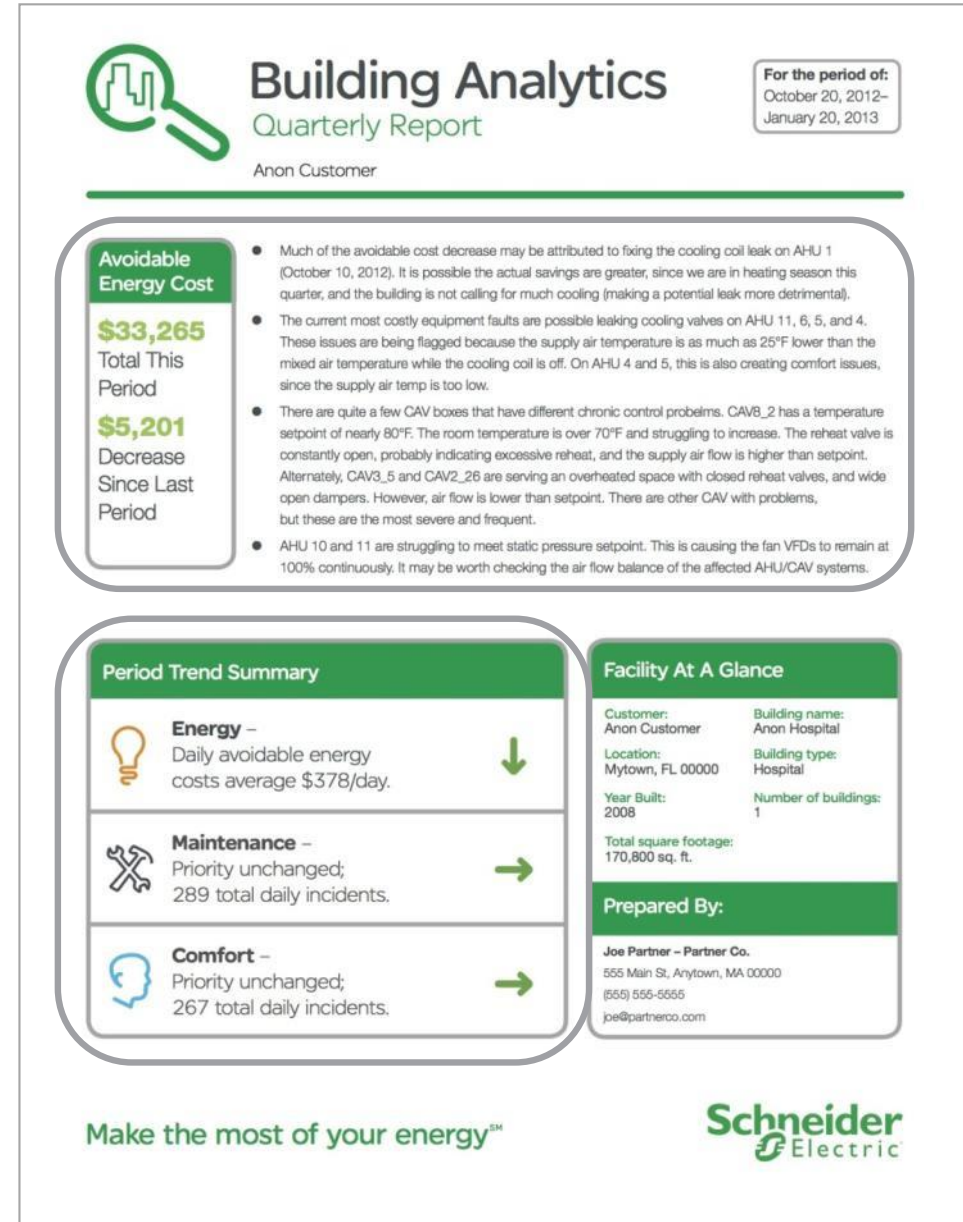




# Custom reporting

## Know the WHY and its impact:

- **Expert Opinion –**  
Avoidable costs and total savings for period, plus analyst commentary on building operating issues
- **Trend Summary – Cost/reduction plus C+E+M (comfort, energy, maintenance) trends**



# Custom reporting

## Know the WHY and its impact:

- Top 5 Issues –  
Prioritized C+E+M issues with cost or severity ratings




- Recommended Actions –  
Hit list of clear recommendations




Quarterly Building Analytic Report


Anon Customer

 2


Top 5 Issues

 Energy

Building	Equipment	Notes	Cost/Qtr.
Anon Hospital	AHU_6_CAVs	Low Damper Position – opportunity for static pressure reset.	\$11,120
Anon Hospital	AHU_11	No supply temp reset. Cooling valve issues.	\$7,778
Anon Hospital	AHU_6	No supply temp reset. Cooling valve issues.	\$6,163
Anon Hospital	AHU_5	Supply temp lower than setpoint. No supply temp reset. Cooling valve issues.	\$5,029
Anon Hospital	AHU_4	Supply temp lower than setpoint. No supply temp reset. Cooling valve issues.	\$4,318

 Maintenance

Building	Equipment	Notes	Severity Priority
Anon Hospital	AHU_11	Static pressure lower than setpoint. Supply fan speed constant. Return fan speed constant.	6
Anon Hospital	AHU_10	Static pressure lower than setpoint. Supply fan speed constant.	6
Anon Hospital	CAV8_2	Room temp lower than setpoint. Stuck reheat valve.	4
Anon Hospital	CAV5_B2	Supply flow lower than setpoint. Stuck reheat valve. – May be sensor error.	4
Anon Hospital	CAV3_11	Sensor error. Stuck reheat valve.	4

 Comfort

Building	Equipment	Notes	Severity Priority
Anon Hospital	CAV1_16	Sensor error. Room temp higher than setpoint. Supply flow lower than setpoint.	10
Anon Hospital	CAV3_5	Room temp higher than setpoint. Supply flow lower than setpoint.	10
Anon Hospital	CAV4_45	Room temp lower than setpoint. Supply flow higher than setpoint.	10
Anon Hospital	CAV2_26	Sensor error. Room temp higher than setpoint. Supply flow lower than setpoint.	10
Anon Hospital	CAV11_22	Room temp higher than setpoint. Supply flow lower than setpoint.	10

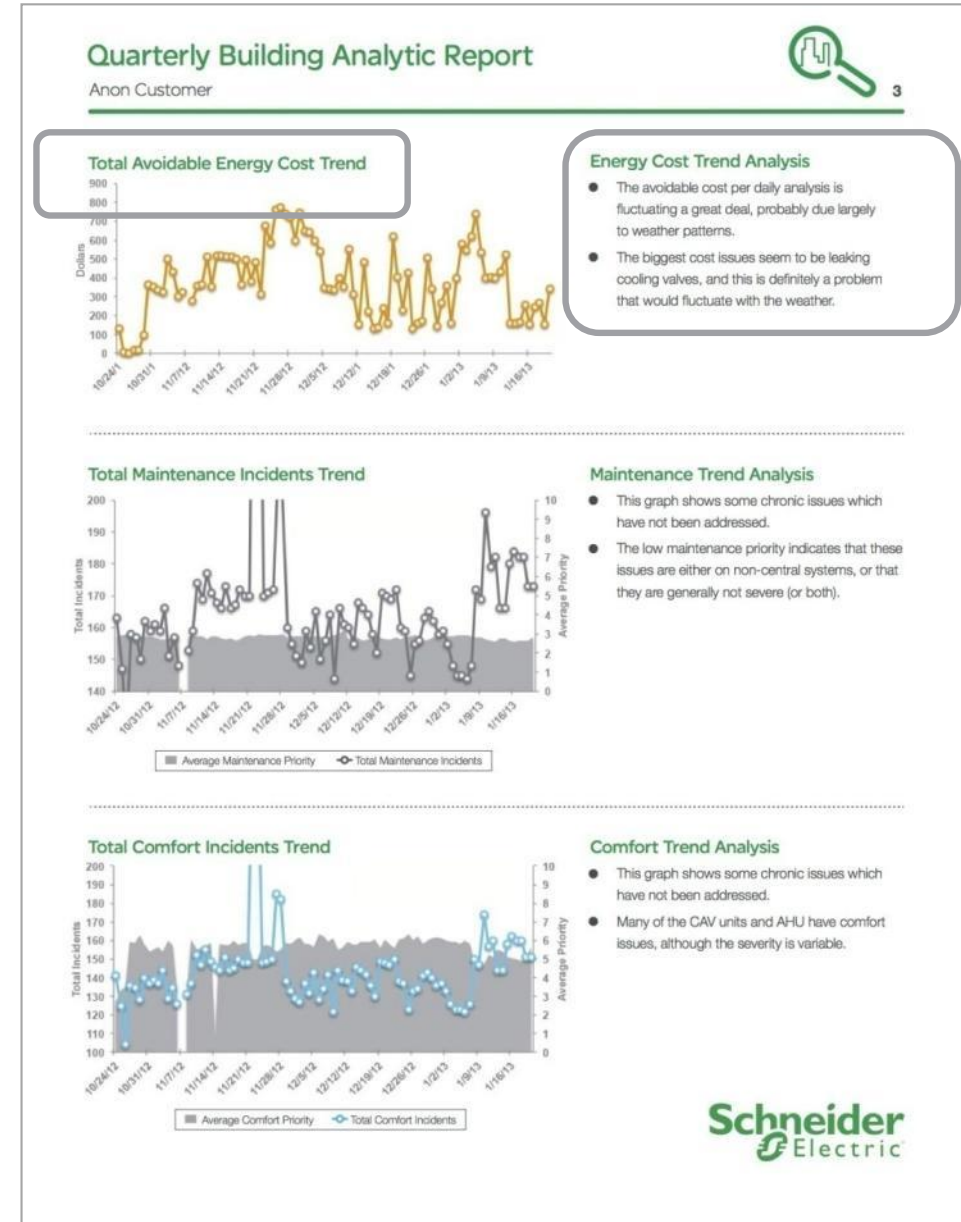
Recommended Actions

- The AHU 6 static pressure is being driven by one zone – you could get over \$11,000 savings by lowering it.
- Review temperature performance and air flow balance of CAV units with high comfort priorities
- Check AHU 4, 5, 6, and 11 for leaking cooling valves
- Check flat-lined temperature sensor in zone served by CAV1\_16
- Explore why AHU 10 and 11 have such low static pressure
- Check CAV8\_2 and CAV3\_11 for stuck reheat valve – valve fully open, but temperature can't reach setpoint

# Custom reporting

## Know the WHY and its impact:

- Performance Trend –  
Trend analysis over time to  
track performance



# Complements existing BMS

## Building Automation System



## FDD Analytics

- Integrates building systems
- Reacts to current state conditions
- Performs control tasks as designed
- Provides notification of nonconformance or exceeding threshold settings



### Ideal for operations & maintenance

Maintain day-to-day building operations

- Adds data analysis
- Identify recurring performance issues
- Provides ROI prioritization of issues
- Ongoing support from experienced building engineers



### Ideal for engineering planning

Pinpoint top comfort, energy, and maintenance (C+E+M) priorities that can maximize O&M resources

# Benefits

Reduce major equipment energy spend  
by 15% to 30%

**Actionable  
intelligence**

Automated fault detection and diagnostics (FDD) – prioritized and available anytime, anywhere

**Centralized expert support**

Centralized system for continuous monitoring-based commissioning (MBCx) to improve and sustain optimal operations

**Measureable results**

Information, not just data, coupled with visualization that delivers real-time results for fact-based ROI decision making

# Summary of FDD Analytics

- Reduces energy spend by **15% to 30%**
- Automated fault detection and diagnostics
- Detailed reports and graphs
- Performance-based utility incentives
- Positive ROI in months
- Lowers carbon footprint
- Increases portfolio value



Provides real impact on energy costs, operational efficiency, occupant comfort, and financial well-being of your buildings

Life Is On



**Schneider**  
Electric