Retailer Trends in Distributed Controls and Electronics

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John Wallace
Director — Innovation, Retail Solutions
Emerson

Sai Krishnan
Vice President of Global Electronics
Emerson
Discussion Topics

Introduction
- Background and evolution of control systems

What’s the difference?
- What are the different architecture “layers” of a control system?

Distributed vs. Central (or both)
- What are the key differences and similarities of the different control architectures? What are the benefits?

What do I need to plan for in the future?
- Is it possible to “future proof” my systems?
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Slight differences in meaning across industries

Generally, BAS implies broader integration, while EMS implies focus on energy management

Refer to a collection of hardware and software to monitor and control the mechanical, electronic and lighting systems

Installed at a single site

For our purposes, these are the same thing
Multiple Factors Drove Evolution of Control Systems From Mechanical to Electronic Systems

- Early refrigeration systems transitioned from “refrigerators” to rack-based systems
- Mechanical control systems operating independently
- Adjustments made directly on equipment
- Difficult to “tune” or optimize
- No “cross-system” integration or optimization
- Limited temperature monitoring

- Advances in sensing technology and electronics enable cost-effective electronic controls
- Electronic platforms enable improved control and optimizations for energy and maintenance
- Regulatory drivers force energy and refrigerant considerations
- Case temperature monitoring for food safety and compliance
Systems Evolved From “Islands of Control” Integrated to Form a Complete Integrated Control System

- Individual systems tied together
- Information sharing across systems
- Emergence of “supervisory functions”
- Integration/Control maturity similar to auto industry evolution
  - Communication technologies
  - More sensors
  - Smarter control
  - Use data to drive actions

Evolution and progress
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Layers and Functions of a Control System

Architecture layer
- Remote
- Supervisory
- Control

Key elements
- Remote user interface
- Site information
- Data feed

- On-site user interface
- User management
- Data logging
- Alarming
- Cross-system coordination

- Control algorithms
- Inputs and outputs
- Sensors and transducers
- Equipment interface

Hardware Can Be Combined or Separated
Integration and Communication Capability Key Part of BMS

Benefits
- Common user interface across site
- Remote access
- Normalized information (alarms, logs, etc.) using operational visibility

Architecture Layer
- Remote
- Supervisory
- Control

Supervisory layer normalizes information to provide alarms, data logs, etc.

BMS

Core HVACR/L

Third Party Devices

Water heaters, energy meters, car chargers, breaker panels, etc.

Third Party Device Statistics

By protocol
- HVAC: 70%
- MODBUS: 27%
- BACNET: 3%
- ECHELON: 6%
- REFR: 53%

By type
- HVAC: 41%
- MODBUS: 27%
- BACNET: 3%
- ECHELON: 6%
- REFR: 53%

Note: Statistics based on Emerson’s E2 support (113 devices)
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A distributed control system (DCS) is a computerised control system for a process or plant, in which autonomous controllers are distributed throughout the system, but there is central operator supervisory control. This is in contrast to non-distributed control systems that use centralised controllers, either discrete controllers located at a central control room or within a computer. The DCS concept increases reliability and reduces installation costs by localising control functions near the process plant, but enables monitoring and supervisory control of the process remotely.

John’s definition: push control intelligence down to the “edge” while pushing monitoring and supervisory functions “up”
Distributed vs. Central: A Familiar Example

Centralized control
- Control algorithms run **in** centralized E2
- I/O boards utilized for inputs, relays

Distributed control
- Control algorithms run **in** distributed controllers
- Communication to E2 for supervisory functions

**John’s definition:** push control intelligence down to the “edge” while pushing monitoring and supervisory functions “up”
Predominant Refrigeration Control Architecture Varies by Region: CO₂ Impacting Future
Comparison of Refrigeration Control Architectures

Centralized control architecture

- Control elements centralized at refrigeration rack or electrical panel
- “Home runs” for sensors
- “I/O” boards for control

Distributed control architecture

- Control elements at case
- Communication “daisy chain” to EMS
- Complete control at refrigeration case
- Case electronics for control
Distributed Case Control Shifts Electronics From Electrical/Rack Rooms to Case and Simplifies Wiring

**Centralized control**

**Electrical Room**
- Elect. Panels

**Refrigeration Room**
- Rack House

- Temperatures (Solenoid)
- Controls
- Sensors
- Fans
- Lights
- Anti-sweat

**Case 1**
- Sensors
- Input Boards
- Relay Boards
- Case Electronics
- EEV

**Case 2**

**Case 3**

**Case control**

**Electrical Room**
- Elect. Panels

**Refrigeration Room**
- Rack House

- Comm Loop
- Defrost
- 120 VAC Feed

**Case 1**
- Sensors
- Input Boards
- Relay Boards
- Case Electronics
- EEV

**Case 2**

**Case 3**

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Distributed Control Change Impact: Better Control With a Completely Integrated System

- **Rack control**
  - Four rack controllers
  - Four rack controllers, but reduced functionality
  - 250+ electronic valves and pressure sensors

- **Valves (EXV and EEPR)**
  - 200+ mechanical valves (self-managed)
  - 100+ controllers (1:1) (we control and drive the valve)
  - Controllers will manage valve (one per lineup; we control and drive the valve at cases)

- **Expansion valve control**
  - Mechanical valve (no intelligence)
  - Fully integrated system solution

- **Evaporator valve control**
  - Eight control boards (centralized controlled)
  - 200+ mechanical valves (self-managed)

- **“The solution”**
  - Purely controls solution and system not integrated (valves are not managed)

System Integration Capabilities and Domain Knowledge Key to Successful Deployment
Distributed Control Benefits

- OEM/equipment providers can factory install and test to deliver a complete working system
- Broader integration delivers more value to end user
- Reduced field wiring and startup time
- Technology flexibility allows best “fit” solution
- Additional sensors provide more data for remote troubleshooting
- Lifecycle cost advantage

Lifecycle cost considerations for distributed case control

Sensors feed data analytics to facilitate cost optimization
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Planning for the Future: Newer Systems Need Flexibility and Advanced Control to Create Smarter Buildings

- "Traditional" control architecture expanding to enable more value
- Flexibility provided by add-on "apps" which facilitate customized solutions
- Site control provides macro level control and coordination of equipment on a cross-site basis (i.e., HVAC/R)
- Transactive services provide opportunity to utilize "smart grid" as well as other cloud-based services (i.e., renewable integration, etc.)
Discussion Summary and Questions

• Global trends driving distributed control architecture transition

• Hybrid systems (i.e., case controllers with centralized rack control) are common and familiar

• Benefits include factory test, reduced startups and potentially lower lifecycle costs

• System integration capabilities as well as domain expertise key to seamless transition and creation of integrated solution

• Advanced capabilities (cloud, transitive, machine learning, etc.) drive need for advanced, flexible BMS which can be utilized with distributed controls

John’s definition: push control intelligence down to the “edge” while pushing monitoring and supervisory functions “up”
Questions?

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