Integrated Application-Specific Controllers: A New Approach to Zone-Level Control

by Jason Estes

Executive summary

Whilst the traditional direct digital control approach to installing zone-level control has served contractors for many years, technological advances have changed the playing field. Today's application-specific controllers integrate sensors, programming, and wiring into a single device, reducing installation time and labor costs by 75%. This paper explains how integrated controllers differ from traditional direct digital controllers, and the advantages they offer.

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Introduction

Technological advances in recent years have made it possible for original equipment manufacturers (OEMs) and systems integrators to install and support automated zone-level room controls more quickly, more easily, and less expensively. Schneider Electric research has shown that using newer application-specific integrated controllers instead of traditional direct digital controllers (DDCs) can reduce installation time and labor costs by 75% (**Figure 1**).

Room controllers are an essential part of any building automation system. They communicate the environmental conditions (temperature, humidity, occupancy) in a given room, or zone, to the various mechanical systems in order to automatically regulate heating, ventilation, and air-conditioning (HVAC), lighting, fans, blinds, etc. Controllers also gather the essential data to feed into a building management system (BMS) that helps facilities managers optimise performance, reduce energy waste, and save money.

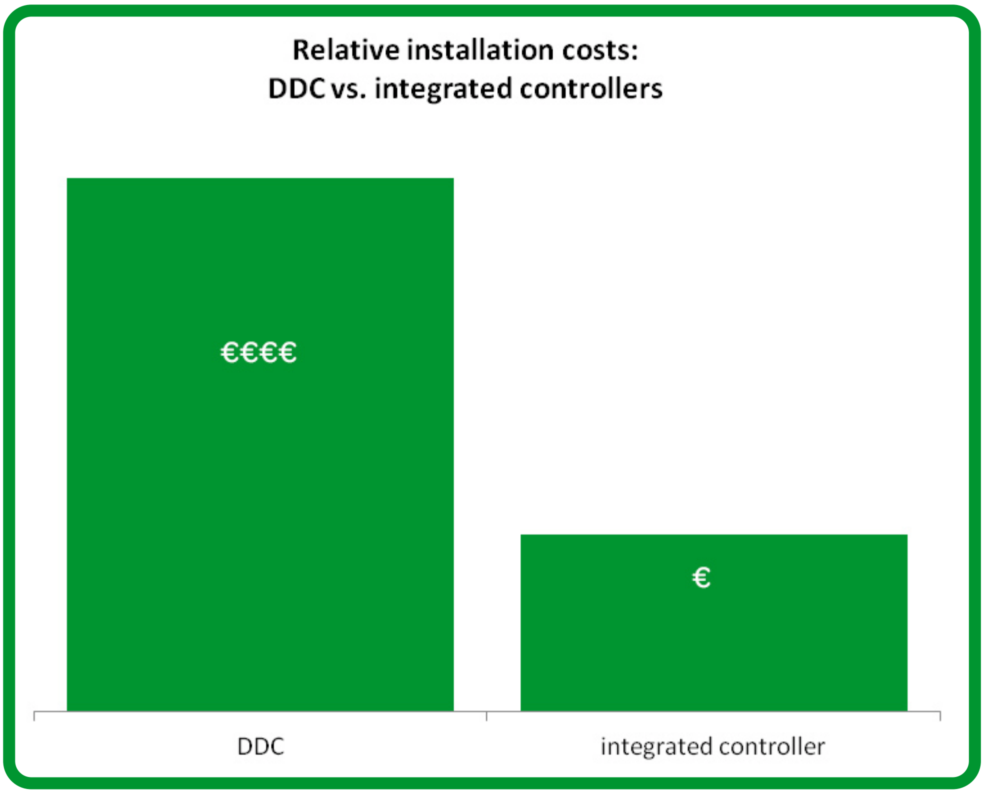

Figure 1
Application-specific integrated controllers can reduce installation time and labor costs by 75%, compared with traditional DDCs.

Traditionally, building automation OEMs and systems integrators have addressed zone-level control using programmable DDCs, first used commercially in the 1960s. These devices are installed by skilled technicians who must program the sensors, wire the devices to the systems to be controlled, and run tests to make sure that everything is working properly.

In recent years, by capitalising on greater miniaturisation and newer technologies like wireless networking, manufacturers have developed controllers that integrate sensors, programming, and wiring into a single device. These devices are pre-engineered with more complete capabilities for specific applications such as heating and cooling, occupancy sensing, and lighting, as well as HVAC equipment like RTUs and fan coils. An electrician can easily install these application-specific integrated controllers without needing to program and wire each one individually, or test the connections. It can be as simple as installing a thermostat.

This paper explains how integrated controllers differ from traditional DDCs, and how this difference can be leveraged to create a better approach for installing and supporting room controllers as part of a BMS.

DDCs: pros & cons

DDCs were first developed in the 1950s, and became a staple of the building automation industry by the 1970s.[1] They have been refined over the years, but the essential idea has remained the same. The DDC contains a programmable chip, with input ports from room sensors and output ports that can be wired to HVAC, lighting, and other system devices, as shown in **Figure 2**. The DDC can then be programmed to interact with those systems, thus controlling the room or zone environment.

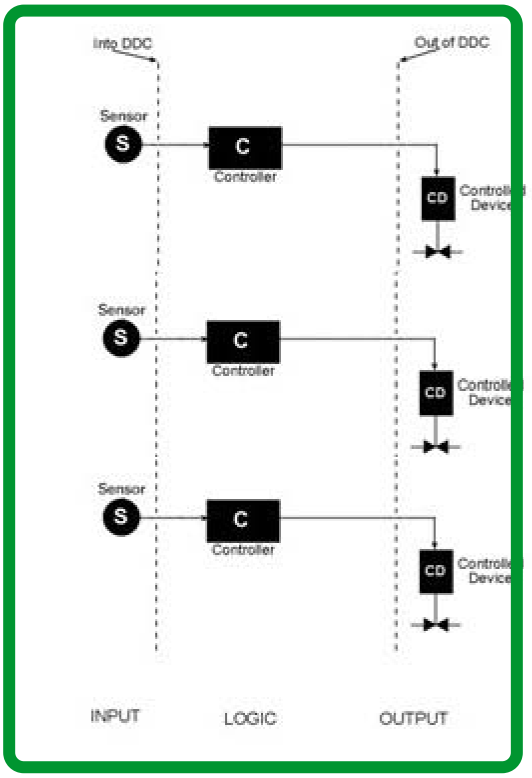

Figure 2
Basic DDC control loop between individual sensors (input), controllers (logic), and controlled devices (output)

Source: www.dc-online.org

For example, a simple application might consist of a DDC wired to an air-conditioning unit and a temperature sensor. The DDC, receiving data from the sensor, is able to monitor the room temperature. If the temperature rises above a certain setpoint, the DDC can automatically turn on the AC to cool the room. Often, DDCs are used to monitor multiple systems in order to maintain zone-level comfort, safety, and security.

Typically, DDCs are general purpose, meaning they can be programmed to control any type of equipment. This is both an advantage and a disadvantage. The advantage is the extreme flexibility that is possible with fully programmable devices, which allows them to be adapted and fine-tuned to almost any degree desired.

"Direct digital controls can be adapted for almost any device, but each controller must be individually programmed and custom-wired."

The disadvantage is the time and resources required to install them. Because each such controller must be individually programmed and connected, this usually requires skilled HVAC technicians who understand how to program as well as custom-wire each controller device for every room or zone in the building. Often the installer must stand on a ladder to reach above the ceiling, pull 120VAC to a transformer to power up the controller, and may even have to mount an enclosure to house the DDC.

The more sensors the controller manages, the more complex the programming and installation become. For buildings with a BMS, the controllers must be programmed to network with the building system as well.

[1] www.building-automation-consultants.com/direct-digital-control-history.html

For decades, DDCs were the only option available for automated room control. However, in recent years a new type of controller — the application-specific integrated controller — has emerged, offering many potential advantages for OEMs and systems integrators.

Integrated room controllers: pros & cons

Integrated room controllers are application-specific devices that are pre-packaged to perform given functions, with built-in programming, sensors, and connectivity.

Functionally, integrated controllers perform the same role as DDCs. They are used to control the various energy-related systems in a room or zone of a building, such as HVAC, lighting, and so on. The difference is that the integrated controllers have the needed capabilities already built into the device, specific to the application for which it was designed. Additionally, integrated controllers use the same proportional-integral-derivative (PID) control logic as DDCs. This advanced PID control logic (when compared to a traditional thermostat) continuously monitors the sensor inputs versus the desired temperature set points. Using the PID algorithm, the integrated controller will modulate the cooling or heating to the space. This advanced method of control saves energy throughout the day, and does not cause premature wear/failure of HVAC equipment, thereby saving energy and reducing maintenance cost of HVAC equipment over its life cycle (**see Figure 3**).

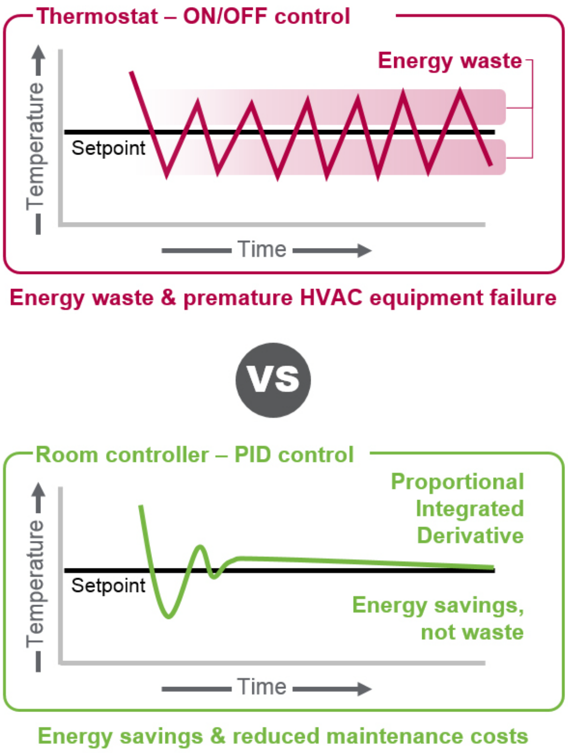

Figure 3
PID stat versus room controller

For example, an integrated controller designed for a hotel room might include sensors and connections for heating and cooling, lighting, blind control, and occupancy sensing, with all related programming and interfaces already incorporated into the device (see **Figure 4**). An integrated controller for a data centre or clean room would have those same controls, plus controls for humidity, chillers, special fans, door sensors, and perhaps other systems. Integrated controllers are available for any building application: fan coil units, heat pumps, remote terminal units, and all the other controls that facility operators require.

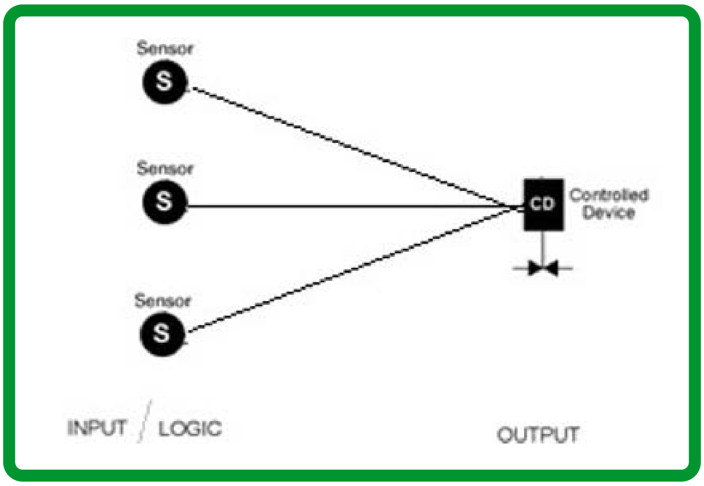

Figure 4
Integrated controllers are pre-engineered with sensors, programming, and connections already built in.

"Integrated controls are less flexible than DDCs, but significantly reduce the time, cost, and manpower required to install them."

In contrast to DDCs, integrated controllers offer less flexibility but can significantly reduce the time, cost, and manpower required to install and activate them. In most cases, integrated controllers can be installed in minutes by a single electrician. There is no need for a ladder or access to the ceiling. The electrician stands on the floor and installs the unit with simple wiring. There is also less risk of human error, since the wiring is as simple as a thermostat and no programming is required.

To provide a degree of flexibility, integrated controllers usually offer a large number of pre-programmed control sequences to choose from. These parameters can be adjusted "manually" if needed, but usually the range of factory-set options is more than sufficient to achieve the desired level of room control and occupant comfort and safety.

If purchased from the same manufacturer, the various integrated controllers will likely have built in the ability to communicate with one another and with a building management system.

Comparing the costs

So, how do the two approaches to room controllers stack up against each other in financial terms?

Of course, every commercial building is different. Location, purpose, type of occupancy, number and size of zones — all these factors have an impact on the choice of room control technology. Furthermore, different systems integrators have their own considerations. For instance, not all technicians have the same skill level, and some may be able to install at faster rates than estimated below.

Nevertheless, a framework for comparing the costs of the two approaches may be drawn, which can then be adapted to specific business and facility situations by plugging in data that more accurately reflects a particular scenario.

For purposes of comparison, assume a typical multi-story commercial office building with 275 individual zones/offices, with the usual complement of conference rooms, lobbies, cafeteria space, etc. Also, to keep it simple, assume no special requirements such as clean rooms, data centres, manufacturing, or the like.

Based on actual in-the-field experience and survey responses from OEMs, Schneider Electric has found that the average time required to install a conventional DDC is 45 minutes. This reflects how long it takes a professional to wire, program, and test the DDC, allowing 5 minutes to move to the next location. Assume an hourly cost of €92 for the level of HVAC technician required to install the DDC units.

Schneider Electric found that the time required to install a pre-programmed, application-specific controller is 15 minutes, including 5 minutes to move to the next location. With no programming or wiring, the process is essentially "mount and test." Assume an hourly cost of €60 for the electrician (vs. an HVAC technician) to install the integrated controllers.

Assuming the building will need a total of 275 room controllers, **Table 1** shows how the two approaches compare in terms of installation cost:

Table 1

Comparison of time and labor costs to install DDCs vs. integrated controllers

	DDC	Integrated controller
# of rooms	275	275
Install time per controller	45 mins.	15 mins.
Man-hours required	206	69
Cost per man-hour	€92/hr.	€60/hr.
TOTAL INSTALLATION COST	€18,952	€4,140

In addition to the cost of labor, time is a factor as well. The integrator working with DDC devices must either take 3 times longer to install the room controllers or hire 3 times as many technicians to get the job done in the same amount of time.

The bottom line: a company could reasonably expect to save on the order of *€14,800 per building* on installation costs, by switching from DDCs to integrated room controllers.

Comparing other factors

Cost is not the only factor when deciding between integrated controllers and DDC. Following are several other factors that should be considered.

Flexibility

As discussed previously, DDCs offer greater flexibility because they can be programmed on-site to interface with any system or device that has an electrical output. Integrated controllers, on the other hand, are much simpler and less expensive to install but are somewhat less flexible. There may be special circumstances where the extra flexibility of the DDC would be needed. For example, direct digital control may the best choice when a highly complex sequence of operations is required for proper control, or where additional I/O is needed beyond the specifications of the integrated controller. But in most situations, there is a strong business case for using integrated controllers over DDCs.

Time to commission

The shorter install time for integrated controllers is an important advantage. Completing the building automation system is a key step toward commissioning the building. Getting there sooner means faster return on investment (ROI).

Risk factors

Integrated room controllers entail less risk of human error than DDCs for two reasons. First, because integrated controllers incorporate tested and validated preconfigured sequences, they preclude the kind of programming mistakes that can happen with direct digital control. Second, because wiring is simpler with integrated controllers (similar to installing a thermostat), there is less risk that inputs and outputs will be connected incorrectly. Consequently, there is less chance that the work will need to be redone — which means a lower risk of cost overruns or project slippage, two critical concerns for building automation contractors.

"For some integrators, the ability to minimise problems for the occupants is as important as cost savings."

Retrofits or new construction

In new construction, any special wiring that may be required for DDCs is not a problem. In retrofits, however, the easy and non-disruptive installation of integrated controllers is a big advantage. There are no ladders required, minimal work above a ceiling, and no enclosures to mount. For some integrators the ability to minimise problems for the occupants is as important as cost savings. It may, in fact, make the project more feasible.

Networking

Both DDCs and integrated controllers can provide networking capability to important protocols such as BACnet®, LonWorks®, and Modbus®. The integrated controller may offer superior connectivity with a building management system in terms of the data it can provide and its ability to be controlled by a central system. Typically, the room controller integrates the various control points and sensors automatically and makes all of that data available to the BMS with no additional work

Scalability

Both DDCs and integrated controllers can be scaled up as needs change. With DDCs, such growth is handled via programming and wiring. As noted, installation of DDCs can be disruptive and expensive. Integrated controllers are much more plug-and-play, as these units typically offer the ability to swap out components. Therefore, it is much easier to add or upgrade capabilities.

Whichever type of controller is chosen, it should be able to support a centralised BMS easily and seamlessly, either now or in the future.

Competitive advantage

The faster installation time and lower total cost of integrated controllers can be used by OEMs to gain an advantage over competitors who use DDCs. This advantage can be realised several ways:

- higher profitability for the OEM or lower and more competitive bids
- faster commissioning
- more flexible scheduling for installation
- non-disruptive installation for retrofit customers

Conclusion

Whilst the traditional direct digital control approach to installing zone-level control has served contractors for many years, a better way has emerged thanks to new technologies. It is now possible to install controllers that are ready-made for a specific application, with input, logic, and output capabilities built-in. These controllers integrate sensor, programming logic, and wiring connectivity in a single device. Installing them is as simple as connecting a thermostat — as opposed to the traditional method of individually programming and custom-wiring each controller. Today's application-specific integrated controllers can dramatically reduce the cost of installation whilst opening up new competitive possibilities for contractors and integrators who install these systems.

Transitioning to this new approach requires some effort and means giving up old habits. But most major vendors offer educational materials such as online training and downloadable manuals. Contractors and systems integrators can be ready to compete with this newer technology in a matter of days. With so many advantages, there is little doubt that the industry is moving in this direction. Converting to integrated room controllers now will position installers to compete in the years ahead.

As a first step, OEMs should review upcoming projects and ask a simple question: "Is the extra flexibility of the DDC necessary for my business or these buildings, or can I achieve the necessary control and occupant comfort with an integrated controller?" For most commercial buildings, the integrated controller will be the more appropriate choice. At the very least, it makes sense for every OEM to investigate the potential advantage of utilizing application-specific integrated controllers to reduce installation time and increase profitability.

About the author

Jason Estes is a Business Development Manager for Schneider Electric. Jason is responsible for growth and development of the Room Controllers and SmartStruxure Lite solution products in the midwest and southern US territories for markets such as healthcare, education, hospitality, and government. He has 7 years of experience in the building automation, energy management, and systems integration industry. Additionally, Jason is a LEED Accredited Professional and holds an engineering degree from Texas A&M University.