Today we are beyond asking whether we should integrate systems for building operations. Integration, or having a single point of control for systems such as lighting, water and cooling and heating clearly makes facility management easier and more effective. Integration helps control utility costs, particularly those associated with HVAC, which the U.S. Energy Information Administration states is responsible for about 40% of a building’s energy costs. Given the return on investment that can be realized by having HVAC systems run as efficiently as possible, this article will discuss commercial integration and the range of options available to building managers and owners.

**Styles of integration**

This section will cover the various styles of integration, beginning with the simplest and working up to the most advanced. An advanced controls system provides more bang for the buck with mechanical systems by introducing efficiencies and making operation and maintenance easier. While many people focus on equipment and not controls when making a purchasing decision, as much or more thought must be put into controls.

**Overview: key to integration is communication**

True integration is not possible without a shared language allowing systems to talk with each other. Before shared languages, attempts at integration were complicated and at times unsuccessful. These early attempts also necessitated using a third-party integrator who could employ their own proprietary language—somewhat like two people who speak a different language relying on a translator.

Building owners and managers who were unhappy with the proprietary nature of the building integration landscape drove a new concept: open protocols. Open protocols allow equipment to interoperate without any “translation” and are non-proprietary. The best-known is BACnet®, a standard protocol developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). BACnet-based devices talk with other BACnet-based devices no matter who developed them.

While BACnet is the most prominent protocol, LONWORKS® and Modbus® are comparable options. Think of it like DVDs winning the market over Blu-rays; the two systems were essentially interchangeable—each offering the same features and benefits—but one gained slight popularity, and then continued gaining popularity because it was slightly more popular. Most integrations will be BACnet-based.

There are other options beyond BACnet, LONWORKS and Modbus, though these options are more obscure—for example, Zigbee and OPC. Note that this obscurity can be a real problem, as integrators may not be familiar with them and that lack of familiarity may breed mistakes.

By not integrating, owners and managers lose out on accumulating any data beyond each individual type (or even piece) of equipment on its own. That is a huge drawback by itself, but if a site is pursuing green certification like LEED® or ENERGY STAR®, this can be a true deal breaker; every day there are more requirements to monitor energy usage.

Additional pitfalls of not integrating include added work for a building or facility manager. This person will need to be proficient on as many systems as they oversee. If, for example, a site has Manufacturer A’s Variable Refrigerant Flow (VRF), Manufacturer B’s Energy Recovery Ventilator (ERV) and Manufacturer C’s lighting it will get cumbersome for the manager to know each brand’s software and controls scheme. With integration, the manager would need to know just one system.

**Discrete logic**

In the discrete logic style of integration, two or more systems are connected via wired sensors and contact closures instead
of talking via a communications protocol. A site would physically connect the wires of Manufacturer A’s VRF with Manufacturer B’s Energy Recovery Ventilator (ERV).

Discrete logic is a very basic form of integration and it has become uncommon. While physically hooking up systems is a low-cost way to integrate that does not require additional controls or the expense of hiring an integrator, facility managers do not have access to the level of data available through use of communications protocols.

Communications protocols provide much more data than discrete logic and return that information in an easy-to-consume fashion (e.g., custom programs, custom graphics). Also, because the setup is so rudimentary, remote support is tricky. With advanced integration, technicians can log in remotely to diagnose and address problems. With discrete logic, most problems will call for in-person, on-site assistance.

**Third-party integration**

In this style, a third-party company integrates the products of multiple manufacturers. Through their proprietary controls system, the integration company would integrate Manufacturer A’s VRF, Manufacturer B’s ERV and Manufacturer C’s lighting.

This style—what people might consider the traditional modern style of integration—is true integration. With actual communication between the systems, the systems operate more efficiently and can be managed more effectively. Further, owners and managers have just one central interface to learn and use.

Despite these benefits, third-party integration is increasingly less popular due to owners and managers feeling “locked in.” With third-party integration, managers may build a long-term relationship with an integration company and use them again and again as they add systems. While this type of relationship may offer customized service, the pitfall is that once a site has significant hardware and programming invested with one integrator it can be prohibitively expensive and work-intensive to change providers.

If being locked in is not a concern, there are still other pitfalls of third-party integration that should be kept in mind. One is the education hurdle in understanding the cost. The cost of third-party integration is not terrible, and having an advanced controls system can decrease lifecycle costs. However, a lot of people experience sticker shock the first time—not because integration is overpriced, but because most people just don’t know what integration costs (or how it will pay back over time!).

An additional concern is finger-pointing. If there is a problem, an integrator will point to the manufacturer, while the manufacturer will point to the integrator. Getting an answer may take more time, and even money.

Finally, third-party integrators may have limited knowledge. They tend to have their own brand of controls, and while they may be well-versed enough in other systems to integrate different manufacturers’ products, this is generally not true when it comes to VRF. Third-party integrators are generally not educated on how a VRF system works, or are not interested in learning about VRF due to its advanced, electronics-based nature. This means integrators need to hardwire into the inputs or outputs from electronics or controls—something third-party integrators avoid doing due to their lack of familiarity with these systems. As a result of not truly understanding VRF, third-party integrators tend to over-control it. Since HVAC is such a large component of a building’s energy usage, this is a key point.

As an example, VRF uses a concept called “Last Command Wins.” In short, a unit will respond to the last command it was given—whether five seconds ago, five minutes ago or five days ago. Third-party integrators use pulse commands, which send a new command every five minutes, for example. Pulse commands work with traditional HVAC systems, but not with VRF. This results in over-controlling the VRF system, and can result in non-optimal commands being executed.

Here is how that might look. In a classroom, a VRF system’s indoor unit has an advanced integration system that can receive commands from three places: the wall-mounted controller in the classroom, the VRF system’s centralized controller or the integrator’s interface (e.g., BACnet interface).

Imagine the interface is set to keep the classroom at 70°F; to do so, it sends a pulse command every five minutes that sets the VRF indoor unit to 75°F—2 p.m., 2:05 p.m., 2:10 p.m., 2:15 p.m., etc. At 2:16 p.m., a teacher feels hot and walks up to the wall-mounted controller, decreasing the temperature to 68°F. The VRF indoor unit, which operates under last command wins, follows this most recent command, and adjusts its set point to 65°F. Within seconds she feels a cool breeze of air flowing, and is comforted knowing the room will cool down. But then four minutes later, at 2:20 p.m., the interface sends a pulse command, adjusting the set point back to 70°F. The cool air stops flowing. The teacher, realizing that the room is getting no cooler, will go back up to the wall-mounted unit and attempt to adjust it again, only to have the interface undo her change a few minutes later. This can cause frustration for occupants or users because even when they change the thermostat, five minutes later, it reverts back. Further, commands that are non-optimal for the performance of the system can be executed even when an occupant or user is trying to break away from the pulse commands because they see something the interface does not. This is not an issue inherent to building integrations, but to third-party integrators who are not aware of VRF’s nuances.
VRF controls engineer support
In this style, Manufacturer A's controls engineers work to integrate VRF into the integration company's controls system that runs Manufacturer A's VRF, Manufacturer B's ERV and Manufacturer C's lighting systems. This is a great option for those already locked in with a third-party integration company but who want the benefit of working directly with the VRF manufacturer. Manufacturers can control their equipment better than anyone else, and some third-party integrators prefer not to integrate VRF due to its complexity. With a VRF manufacturer setting up the back end of the controls, the correct commands and amount of programming will happen, ensuring peak performance of the VRF system. “Last command wins” versus “pulse commands” ceases to be an issue.

Top-quality control also means better, more efficient operation, as well as a higher level of information available to the end user (e.g., trending). A VRF manufacturer will also be able to control a much greater number of points within the VRF system than a third-party integrator.

The VRF manufacturer can integrate points such as, but not limited to, the following:

<table>
<thead>
<tr>
<th>Air Direction Setup</th>
<th>Night Purge State</th>
<th>System Alarm Signal</th>
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<tbody>
<tr>
<td>Air Direction State</td>
<td>On Off Setup</td>
<td>System Forced Off</td>
</tr>
<tr>
<td>Air to Water Mode Setup</td>
<td>On Off State, Number of ON/OFF, Cumulative Operation Time</td>
<td>Thermo On Off State</td>
</tr>
<tr>
<td>Air to Water Mode State</td>
<td>Operational Mode Setup</td>
<td>Trend Log Controller Electric Energy</td>
</tr>
<tr>
<td>Alarm Signal</td>
<td>Operational Mode State</td>
<td>Trend Log Group Appointment Parameter</td>
</tr>
<tr>
<td>Controller Alarm Signal</td>
<td>Prohibition Mode</td>
<td>Trend Log Interlocked Units Appointment Parameter</td>
</tr>
<tr>
<td>Controller Electric Energy</td>
<td>Prohibition On Off</td>
<td>Trend Log Interlocked Units Apportioned Electric Energy</td>
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<tr>
<td>Error Code</td>
<td>Prohibition Set Temperature</td>
<td>Trend Log Pulse Input Electric Energy</td>
</tr>
<tr>
<td>Fan Speed Setup</td>
<td>Pulse Input Electric Energy</td>
<td>Trend Log Room Temperature</td>
</tr>
<tr>
<td>Fan Speed State</td>
<td>Room Temperature [Water Temperature]</td>
<td>Ventilation Mode Setup</td>
</tr>
<tr>
<td>Filter Sign [Circulating Water Exchange Sign]</td>
<td>Set High Limit [Setback Temperature]</td>
<td>Ventilation Mode State</td>
</tr>
<tr>
<td>Filter Sign Reset [Circulating Water Exchange Sign Reset]</td>
<td>Set Low Limit [Setback Temperature]</td>
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</tr>
<tr>
<td>Group Appointment Parameter</td>
<td>Set Temperature [Set Water Temperature]</td>
<td></td>
</tr>
<tr>
<td>Group Apportioned Electric Energy</td>
<td>Set Temperature Auto</td>
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<tr>
<td>Interlocked Units Appointment Parameter</td>
<td>Set Temperature Cool</td>
<td></td>
</tr>
<tr>
<td>Interlocked Units Apportioned Electric Energy</td>
<td>Set Temperature Heat</td>
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</table>

A comparison of service and details of non-integrated control systems, manufacturing-specific control systems and everything in between.

A VRF manufacturer will be able to pull these automatically and more quickly than a third-party integrator, which would have to map each point one at a time. If there are 1,000 points, that is a big difference in labor.

Third-party integration with a boost from the VRF manufacturer's controls engineers is also a helpful option for sites that already have a sophisticated building management system (BMS). With this style, sites reap the benefits of a VRF manufacturer's knowledge without needing to replace an existing system. The VRF manufacturer will use a BACnet license on the third-party integrator's controllers and give full read/write capabilities to that company. This communication on the back end ensures that the VRF system can be integrated into the third-party's controls' front end.

As far as pitfalls with this style of integration, the previously mentioned finger-pointing issue remains. If something goes wrong, which integrator or manufacturer is responsible? Additionally, this style involves paying two integrators—the third-party integrator and the VRF manufacturer.

Manufacturer-specific controls
In this style of integration, the integrator is not a third-party company but a manufacturer of one of the systems to be integrated. Manufacturer A’s controls engineers integrate Manufacturer A’s VRF, Manufacturer B’s ERV, and Manufacturer C’s lighting via a common integration protocol. At this point, only some manufacturers are offering this service.

This is the newest style of integration, and it offers more efficient control of a building from an energy standpoint. It also has the general advantage of having a full, advanced integration. As with turning to a third-party integrator, but
getting a boost from the VRF manufacturer's controls engineers, turning to the VRF manufacturer for the integration means peak performance, top-quality control, more efficient operation and a higher level of information available at greater speed due to the manufacturer's access to the largest number of VRF system points and ability to pull information automatically. That means money saved on labor.

With a single provider for both the BMS and VRF equipment, managers have a single point of contact for the most important and complex type of equipment that gets integrated. Finger-pointing is eliminated. Also, as may please those concerned about being locked in, most manufacturers currently offer integration use open protocols—primarily BACnet—so service providers can be switched down the line.

Another benefit: reliability. Since the VRF manufacturer can be a large, trusted brand with a long history, owners and managers don’t have to worry about an integrator going out of business in the middle of the job.

The final pitfall is the potential loss of a good thing. If this is a site’s first and only BMS but owners decide to move away from the manufacturer down the line, for example, to a third-party integrator or a different manufacturer, managers won’t get the advantage of full knowledge on any new equipment. And as has been driven home here, that full knowledge is so important when it comes to HVAC, since HVAC is such a big component of a building’s energy usage. While manufacturers who are also integrators use open protocols such as BACnet as part of integration, each integrated system (e.g., VRF, ERV, lighting) runs based on proprietary information of which only the manufacturer of that system is aware. If a VRF system’s manufacturer is also the integrator, owners and managers have access to the proprietary information that makes the VRF system run as efficiently as possible.

**Conclusion**

Now that you’ve read more about integration, what systems in your building(s) would you want to integrate? What data would be of use in keeping costs down, keeping occupants safe and comfortable? Because, at this point, remember that the question isn’t “Why integrate?” but “How do I best integrate?”

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