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Project Haystack

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# connections

Journal of the Haystack Community - Solutions for Interoperable Device Data

# Making It All Work Together

- Haystack 4 Update
- Getting Inside Project Haystack
- Taking Project Haystack and Niagara to the Real IIoT
- Enabling Plug-n-Play Small Buildings
- The Future of Building Control

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From the Editor

# Making It All Work Together

***by Robin Bestel, Managing Editor***
***Project Haystack Connections Magazine***

Welcome to the Fall 2020 issue of the Project Haystack Connections Magazine. This eighth issue demonstrates how the Haystack Community has continued to further solidify the value brought by its widely adopted open-source methodology for semantic tagging in the built environment.

Project Haystack has continued expanding the standards for semantic modeling methodology and building on the tagging libraries for more and more applications. This community-driven, open-source process is engaging companies that work on different facets of specifying and implementation. They understand the importance of "Making It All Work Together".

The Connections Magazine Fall 2020 issue consists of articles, conversations and updates from Project Haystack members and supporting companies. Here are just a few highlights - a conversation between Lewis Martin of CM Industrial and Project Haystack Executive Director John Petze, ***"The Role of Open Source - Getting Inside Project Haystack***". Richard McElhinney, Chief Software Architect at Conserve It, contributed an article on "***Taking Project Haystack and Niagara to the Real IIoT***". "***The Haystack Byte Journey Continues***" is an article written by Alper Üzmezler, Managing Partner of BAS Services & Graphics. Paul Ehrlich, P.E., Founder and President of Building Intelligence Group LLC, collaborated with Veronica Adetola and Draguna Vrabie of the Pacific Northwest National Laboratory (PNNL) on two articles, ***"The Future of Building Control – Rule-based or Predictive?"*** and ***"Co-Design a New Process to Improve Control System Design and Delivery"***, both highlighting the importance of tagging to achieve the goals of advanced control. ***"Enabling Plug-n-Play Small Buildings Using Haystack Tagging"*** was contributed by Scott Muench, Vice President of Customer Experience at J2 Innovations. Rob Glance, Vice President Information Technology of BuildingFit contributed the article ***"Finding Our Way: Take the Established Success Path for Implementing Building Analytics"***. Jean-Simon Venne, CTO of BrainBox AI, contributed his article "***Resolving Pain Points in Tagging Via the Use of Artificial Intelligence***".

Brian Frank, Technical Lead of Project Haystack, provides an update on Haystack 4. The Project Haystack website, **www.project-haystack.org**, is being transitioned to the new Developer website, **www.project-haystack.dev**, to focus on the new Haystack 4 methodology and assignment of tags. The activities of the Working Groups and the developer Forum conversations will be transitioned to the Developer site soon, as well.

John Petze, Executive Director and Marc Petock, Executive Secretary of Project Haystack contributed the following two articles respectively, ***"Data Semantics in The Built Environment: Learning the Concepts of Data Modeling of Facility and Equipment Systems"*** and ***"Smart Analytics Requires Smart Data"***.

Since our last issue of Connections Magazine, e-Magic became the newest Associate Member of the Project Haystack organization.

And we are happy to announce under Events, to **SAVE THE DATE** for **Haystack Connect 2021**. It will be a virtual conference held May 4 - 6, 2021.

Project Haystack Working Groups contributed updates to their work. And as always, we have sections dedicated to Tools for Developers and Integrators and How to Get Involved, a curation of social media highlighting Project Haystack Members new Projects, Practices and Products, and our Members Directory. There is a list of all the Advertisers, to whom we thank for their sponsorship that supports publishing our Connections Magazine.

Thank you again to everyone that contributed to this Fall 2020 Project Haystack Connections Magazine. To people reading this magazine for the first time, more information about Project Haystack and how to become a member, is available at **marketing.project-haystack.org** and for Developers, please visit **www.project-haystack.org** and **www.project-haystack.dev**.

I look forward to working with everyone again to create the next Connections Magazine in 2021 as we celebrate the 10th Anniversary of Project Haystack.


## FIN microBMS: Small can be smart

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Project Haystack's View

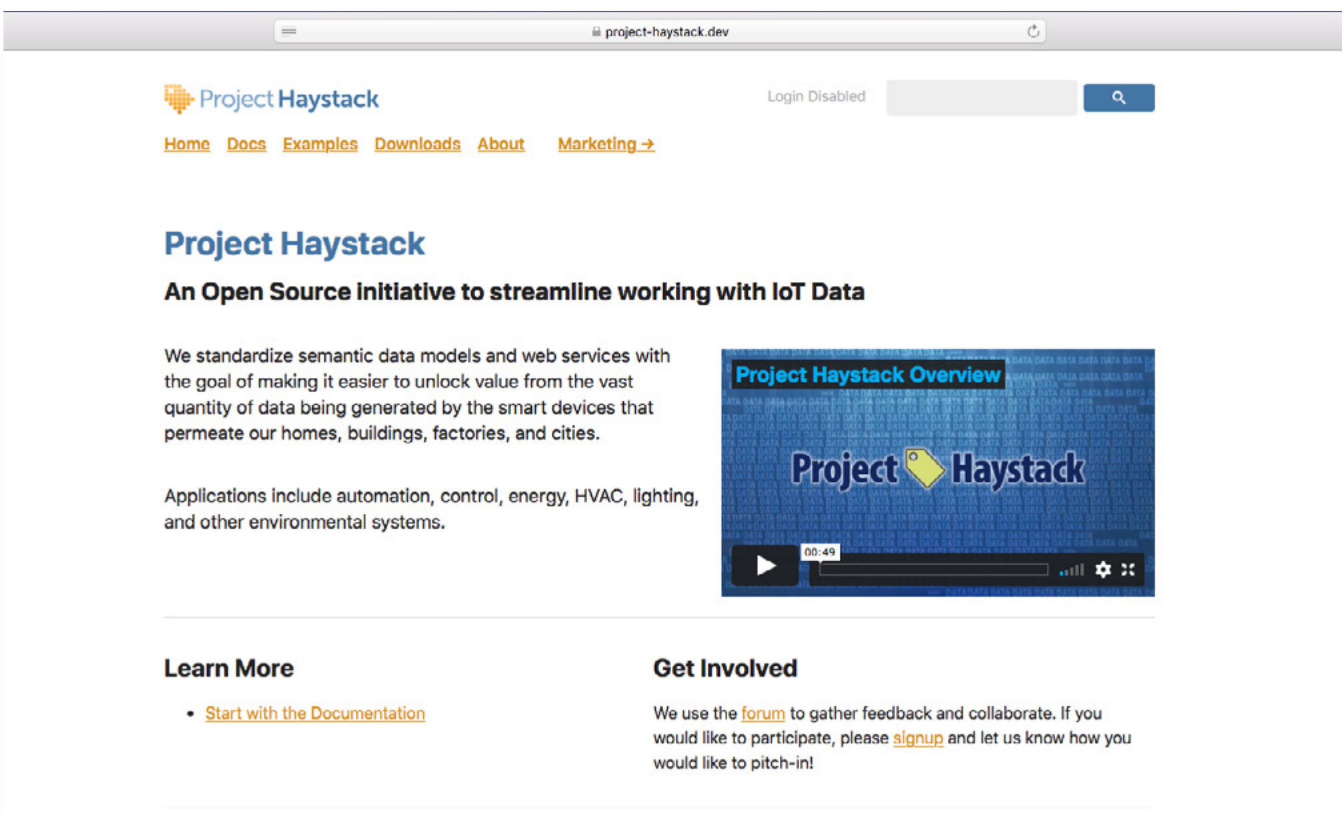
# The Update on Haystack 4

Haystack 4

Haystack 4 continues to make refinements to our next generation ontology. As a reminder, the Haystack 4 public review is being run on a parallel website: www.project-haystack.dev. In July we posted another preview release which is version 3.9.9. This preview includes several exciting new features.

The www.project-haystack.dev website has been enhanced with a new top-level tab titled Examples. This new section provides a friendly way to browse Haystack models of real-world sites. For the initial release, three members of the community have donated a model of a complete building as a public data set. These datasets can be easily downloaded in any Haystack file format to use as reference material, research, or future validation work. If you have your own example models which you wish to donate, please let us know.

The 3.9.9 preview also specifies the final design for flow relationships. This has been an ongoing effort which was arguably kicked off several years ago by WG 501. This new design uses a consistent naming convention to model flow relationships between equipment. Unlike Haystack 3 tags which used a naming convention based on equip type, the new Haystack 4 tags are named strictly by the flow substance. Examples of these new tags are airRef, elecRef, chilledWaterRef, and steamRef. See the updated www.project-haystack.dev website for details.



The latest release also includes several new rewritten chapters of documentation. A new Intro chapter introduces the core concepts of Haystack 4 and the ontology. A rewritten Kind chapter includes a much deeper level of details on the core data types than the original documentation. And we've added a brand new Filetypes chapter which provides an overview of the suite of Haystack file formats.

Also included the 3.9.9 preview release is the latest work from Lighting WG 705 and AHU WG 609. Both of these workgroups have further refined equip and point tags which are now incorporated into the Haystack 4 preview.

There are several activities planned for the next few months on Haystack 4. We are planning to propose how the HTTP API operations are defined via Haystack 4 defs. Also, several enhancements to the query filter syntax are under active development to bring inference engine capabilities to Haystack implementations. And there are several fledging activities towards development of equip templates which might become pivotal in providing a standardized validation framework.

Brian Frank serves as the technical lead for Project Haystack, working with the Project Haystack community to curate domain models and technical specifications. He is also President and Co-Founder of SkyFoundry, a software company specializing in storage, analysis, and visualization of data from the IoT.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**Conserve It is an international leader in Smart IoT Solutions, Smart Building Solutions, Automation and HVAC controls, having designed an award-winning central plant room optimization solution as well as being a founding member of Project Haystack.**

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conserveitiot.com info@conserveitiot.com Project Haystack Founding Member

Project Haystack's View

# Data Semantics in The Built Environment: Learning the Concepts of Data Modeling of Facility and Equipment Systems

**"Applying semantic modeling to facility and equipment system data is a relatively new field. Many in the buildings industry are being introduced to the concepts, and need to learn them, in order to satisfy customer desire to utilize operational data to improve efficiency, comfort and safety and achieve true "data-driven" facility and energy management."**

As early leaders in the field, the Project Haystack community has produced a wide range of educational materials to help people gain the necessary understanding of key concepts involved in semantic modeling of facilities and equipment systems. The following narrative is designed to guide new users through the core concepts, and into the more recent developments, that have extended the Haystack tagging standard.

## Where to Start – The Core Concepts

Like any new technical topic, the educational journey starts with basic concepts and progresses to higher levels of detail and sophistication.

This primer, Introduction to Project Haystack, is a great place to start for an introduction to the concept of semantic modeling, the need in the built environment, and the solution provided by Haystack tagging. It focuses on the basic concepts. Other resources highlighted below will take the reader into more depth.

## Next Step – See How Others Did It

Having absorbed the background provided by the primer, the next recommended resource is to review a reference implementation that shows the application of tags in a sample project: Reference Implementation – Applying Haystack Tagging for a Sample Building.

Also, helpful on this topic is the work shared by the State of Utah, who undertook to define appropriate tagging for all of their equipment systems and shared the work with the community: State of Utah Haystack Tagging Reference Model Example.

## On to the Next Generation of Haystack – Haystack 4 Extended to Add Support for Defined Taxonomies, Ontologies and More

All of the resources above represent use of the first generations of the Haystack standard, often referred to as Haystack version 3. This work provided the building industry with a standardized approach and defined vocabulary for "marking up" equipment systems and their data.

Building on the success of Haystack 3 and the experience and input from the open-source community, a 2+ year effort was initiated to extend the standard to add support for defined "taxonomies" and "ontologies". This was a natural progression, adding more advanced features to the standard as practitioners from around the world applied the initial standard to real-world projects and advanced their own knowledge and experience with semantic modeling of facilities, equipment systems, sensors and devices.

This article, **Haystack 4 is Coming. What it is and Why it Matters**, provides a summary of the enhancements that Haystack 4 brings to the standard.

## Haystack 4 Reference Implementations Provide Fully Developed Examples in Real-World Projects

To support the adoption of the new advances provided by Haystack 4, the community undertook to provide fully, fleshed-out examples using actual project examples. Three different contributors from the Project Haystack community donated anonymized datasets of fully tagged, real-world projects that clearly show how to apply the concepts of Haystack 4. The models include steam, hot water, and chilled water plants along with AHU, FCU, and VAV air systems. The projects are generically named using the phonetic alphabet.

These reference projects can be found on the **Haystack 4** website **Examples** to allow users to browse the sample datasets and follow links between all their ref relationships. Plus, each project dataset can be downloaded via one of the standard Haystack formats: Zinc, JSON, Trio, Turtle, JSON-LD, or CSV.

These public datasets aid users in getting started with Haystack 4 and will hopefully spur the following:

- Inspire others to donate their real-world building models.
- Public review to determine if these are "good" reference models.
- Analysis of the use of custom tags (which were left in the datasets using a special custom tag) to indicate areas where Haystack can be enhanced. (Note that obvious vendor-specific tags are not included.)
- Download datasets for use to test code such as Zinc parsers, Machine Learning-based naming algorithms, RDF tools, etc.
- Accelerate the work to build-out "equip/device templates". The infrastructure to display Haystack data in a browser with cross-referencing to defs/other entities is ideal for use when we are ready to add predefined "equip/device templates".

As we noted at the start of this article, applying semantic modeling to facility and equipment system data is a relatively new field. As data becomes more critical to facility management and all aspects of society, the efficient and consistent application of data modeling is essential to achieve the end-goal of smarter, more efficient buildings and operational services.

On behalf of the Project Haystack organization, I would like to thank the community members that donated their Haystack project databases and all members of the worldwide community that have contributed to the Project Haystack journey, which will celebrate its 10th Anniversary in March of 2021.

John Petze is the Executive Diretor on the Board of Project Haystack, and Co-Founder and Partner of SkyFoundry, the developers of SkySpark®, an analytics platform for building, energy, and equipment data. John has more than 30 years of experience in building automation, energy management and M2M.

Project Haystack's View

# Smart Analytics Requires Smart Data

**"Deciphering data and making sense of it can be strenuous and extremely time-consuming. The data must be organized into a common data model with consistent tagging identification to make it interoperable. It also needs to be able to be applied to any application, service offering and use case."**

Having access to data is not the same as controlling it and making meaningful use of it. Knowing which data to collect and giving it uniformity is the key. The challenge most organizations face is determining what data is relevant, how to standardize it, how to give it common context and how to streamline it to unlock the data's true value.

## Enter Haystack Tagging

Haystack tagging, developed by the Project Haystack organization, standardizes semantic data models, simplifies the interpretation of data collected across the different operational systems and makes it easier for building owners and operators to understand, analyze, and make comparisons. It enables users to view the data the same way, speak the same language with a common and consistent descriptive representation and tagging methodology. The result is a dramatic reduction in the complexity, time, and cost of unlocking the value of data produced by today's intelligent buildings systems.

I am often asked what are the business benefits of Haystack Tagging?

While there are many, here are a few of my favorites:

**Data that Provides Confidence.** Data that is tagged and consistently modeled is easy to understand and interpret. It takes the guesswork out of the equation and makes it more immediately useful across an organization. People can assess the usefulness of the data for these applications without the barrier of different data formats clouding their view.

**Data that is Usable.** Because the data has clear, consistent, semantic descriptors, you can move to the value-generation processes more quickly, speeding up the time it takes to gain value from the data.

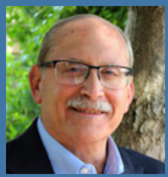
**Organization and Operational Alignment.** Defined tags and data models drive alignment and consistency across organization departments. They unite disparate interpretations across the organization into an aligned view of the building's operations. This means fewer meetings with stakeholders in which you attempt to get everyone on the same page, as well as less assistance when it comes to interpretation of data analysis.

**Scalability.** Having a standardized, repeatable data model with tagged data reduces the need to constantly change approaches as you encounter and integrate new data sets.

**Outcome Acceleration.** Time to value. Need I say more?

A common data model with consistent tagging identification turns integrations, that were once complicated and expensive, into data-driven applications that are lower in cost and are portable, and repeatable across buildings. A common methodology is an important step towards making all buildings smart. The Project Haystack tagging methodology reduces the cost of smart building systems and allows operational teams to better understand and improve the operation, management, control, and performance of buildings.

Project Haystack enables smart data. Smart data enables smart building analytics.



Marc Petock is Executive Secretary on the Board of Project Haystack and Chief Marketing & Communications Officer at Lynxspring, Inc. Lynxspring is a Founding Member of Project Haystack and leading developer and manufacturer of smart building technologies and solutions.

CM Industrial Conversation

# The Role of Open Source - Getting Inside Project Haystack with Executive Director John Petze

CM. Industrial.

**"Open source is the future of smart buildings, bringing countless benefits to building owners, property managers, end users and automation providers."**

**"Open-source software is a type of computer software in which source code is released under a license that allows the copyright holder to use, study, change and distribute the software to anyone and for any purpose. That means open source software can be developed in a collaborative public manner."**

In smart buildings, Project Haystack is the leading example for open source solutions. It promotes a community driven approach that focuses on the development of standardised tagging conventions and taxonomies. Its goal is to provide semantic meaning to the operational data produced by equipment systems and smart devices.

Standardizing data tagging would mean that all collected data from devices could be both machine-readable and people-readable - reducing engineering hours for back-end tasks like data processing and mapping. This will make processes more streamlined, sustainable and cost-effective.

To learn more about the initiative, Lewis Martin of CM Industrial spoke to John Petze, Executive Director and a founder of Project Haystack.

**LM:** To start off, can you tell us a little bit about yourself and about your background John?

**JP:** Sure. So, my name is John Petze and my day job is with a software company called SkyFoundry. We make a software platform called SkySpark®, which is used to consume and analyze data that comes out of IOT devices in built environments of all types.

This data can be anything from meter data to equipment and operational data, temperature data, weather data and so on. The software performs analytics to find issues and find patterns that represent faults, deviations and opportunities for improved performance, as well as comfort and safety.

I've been in building automation, industrial automation and energy management for 35+ with a variety of manufacturers in both hardware and software that's involved in automating and controlling.

My night job, or my volunteer job, is with an open source organization called Project Haystack. This is a worldwide open source initiative to define metadata standards for marking up or defining the meaning of all of the data that comes out of these highly diverse systems.

LM: You've been working in this industry for 35 years, so how much have you seen that landscape change during your career?

JP: In terms of IoT, that certainly wasn't there at the start.

But connecting computers and electronic devices, connecting them over networks and bringing that information onto a pane of glass on a computer, that's been happening since the early eighties.

Having said that, the technology has certainly got better. What you see on that pane of glass is no longer just a green screen.

Networks used have changed too. There's been an explosion of devices that are being cost-effectively produced and connected to networks. Their value is in the information they provide to improve life, to improve efficiency, to improve comfort, safety and so on.

LM: How smart are buildings nowadays? How much do they take into account and how does IoT play into that?

JP: I always try to make an important distinction between buildings that are connected and buildings that are intelligent because the two things are separate.

We can put a lot of people in a room to talk with each other, right? The communicating doesn't mean that we're working intelligently on a problem together.

And so, there's been a huge advance in the enablement of communication in building systems. But to get intelligent operations, requires coordination among those systems. And because there are so many different devices, systems, brands, manufacturers… who should organise the coordination?

In the early days of building automation, that was done by the one manufacturer you chose. Anything that was going to be connected in your building would have to be connected to that system. They were the aggregator and coordinator.

Now, when we talk about intelligent buildings, is intelligent coordination across different products, devices and data sources in a building. For example, so that we can correlate our energy data - coming from a meter that may be from one manufacturer - with the operational status of our equipment that might be coming from one or more other vendors' products. So, we can see the influence of how the operation of equipment affects our energy. When these pieces of equipment turn on, this is what causes peak to my energy. That's an aggregation and a correlation, which is the first step in intelligence.

The next step is, when we see these relationships or correlations, for the control system to take action. To do load shedding, start to do other sequences and strategies to intelligently respond to what's being found. That's the end goal with intelligent buildings, from my perspective of controlling the environmental – the comfort, the lighting, et cetera.

LM: Is AI machine learning coming into this?

JP: Yeah. That is one technique that can be applied to get to our goal.

There's a lot of new technology out there and buzzwords do take over. AI is not a panacea for everything in a building. AI is a tool that works well with certain types of problems, but there's other advanced math techniques for pattern recognition, frequency, domain analysis, calculus. There's a whole suite of math techniques that are applicable to analytics of building system data. Machine learning is an important one, but it shouldn't be confused as a type of magic that just solves everything.

And in fact, if you follow the field of AI and read the different marketing literature and listen to the people involved, they'll tell you that one of the biggest challenges is the data preparation to feed into AI algorithms. Once the algorithms were written, all of the work comes down to getting the data and processing and prepping that data so that it can be used by the AI algorithms.

Of course, that gets to one of the topics that we wanted to talk about today; the work I'm doing with Project Haystack group and what we're doing to come up with a standardized methodology of how we should describe what these data items are. In other words, add descriptors, but add them in a uniform, standardized, approved way so that we can say: 'this is a temperature sensor, measuring air in a room during occupied hours. Now, an algorithm can make some decisions and determine that behavior and whether it's right or wrong.

**LM:** So, my understanding is that you've got this building that's got a huge range of different data sources that are all from different manufacturers, different places that are sort of saying things that you can understand, but perhaps in different languages.

And Project Haystack has created something that democratizes that language through which everyone can communicate. And that works through a process of tagging?

**JP:** Yeah, tagging describes facts about the data. I like to bring people into the thought process about what we're doing for data semantics, which is a kind of an esoteric word.

I bring it in this way. You have a website and I can bring up my browser and go to your website and read everything you've published. Now, did I get my engineer to talk to your engineer ahead of time so that we could figure out how my computer can read your website? And the answer is, no. We didn't have to do that because it already got solved for us.

The industry, early on in the history of the web, developed a standardized marked-up language. You can put whatever text you want on your website, but you're going to use certain mark-up conventions that my browser can read and go 'oh, this is bold', 'here's a line feed here', 'we're going to embed a picture here'. HTML is a mark-up language.

The work we're doing at Project Haystack is similar. It's a mark-up language, but it's specifically about the data. So, we can add tags to a temperature or to a sensor and say that it's temperature air, pressure or whatever. And then when a software application or control system and analysis app consumes it, it knows what it is.

The most basic thing I say to people is: 'if you say a number to me, it has no meaning, unless you give me units.' Units are the simplest mark-up to a piece of information that allows us to interpret meaning. All we're doing with Project Haystack is bringing together industry experts who deal with IoT devices, control systems, devices and sensors to agree on a standardized vocabulary of how we'll describe the attributes of these things and a standalone standardized taxonomy of how things are organized.

Then software applications can consume data and automatically know what it means, so they can make higher level intelligent decisions. We want to be able to make sure that all of these great devices out there and their data can be used effectively, efficiently without a lot of unnecessary engineering effort so that we can get to more intelligent operation and better insights from the data that they provide.

**LM:** How long has Project Haystack been in existence then? How did you get involved with it?

**JP:** It was formed in March of 2011, so it's been out there nine years. It's an interesting story of how we got involved. It helps show the challenge and why this is needed.

We formed our company, my day job, SkyFoundry in 2009. We started working on this challenge of building software to do automated analytics on machine data, operating data out of equipment systems. The first challenge we ran into was having similar data that all have different names. So, we asked, "What standardized approach has the industry developed to deal with this problem?"

Back into 2009, based on my experience and others, we found the industry hadn't dealt with it yet. While the world-wide web had come up with HTML, the industries involved in controls automation, whether it be commercial or industrial or sensors and emerging IoT, had never dealt with the problem.

So, you could buy a device from Manufacturer A and the only way you can interpret their information was with the instructions they gave you for their device. And then Manufacturer B would do it in a totally different way, et cetera.

This even existed with devices that use a standard protocol. In industrial systems, there's a very common protocol called Modbus. Lots of devices talk Modbus, but if you want to know what the device is saying to you, you have to get what's called the register map from the manufacturer. This tells you how they use it and what each register means.

So, if I wanted to integrate all these devices, I ended up with this huge amount of manual effort. We saw this problem and worked internally to come up with a methodology to define descriptors.

We looked at what was happening and the bleeding edge of software, and tagging was an emerging field. We stayed on a tagging methodology and we built a way to tag the data in our software so that we could work with it.

We looked at each other one day and said that this is not actually a competitive advantage for us. This is a fundamental problem. We went out, we talked to some of the US government labs, research labs, energy labs and industry leaders, and they all agreed. We said, "We've got this idea that uses tagging to solve this, but we need an open-source consortium."

We got a great response. I wanted to get some of the labs involved and they said, they'd be happy to join us after they'd made a proposal and that it'd take a year or two to get funded. They wanted us to get started and to join us later.

So, we took all the work we had done and we open-sourced it, setting up a server. We talked to friends, associates and people who were involved in this problem and said "Hey, come join us. Let's solve this problem in an open source way." We set up an open-source initiative that launched in March 2011 and people started joining us to find a solution.

In 2014, we turned it into an official 501(c) non-profit trade organization, so that we could produce events, expend money on marketing and we could take a membership and dues so that we could, you know, have some funds to support the operation.

So, that's when it started, and it's continued to evolve because it's handled in an open-source method. So, somebody comes in and says "Hey guys, I know lots about electric meters. Here's my proposal on how we should define the descriptive tags and the taxonomy relationships for electric meters or electrical distribution systems, or chillers or boilers, or you name it." And then, the birds of a feather get together and work in groups to tackle a piece of equipment or a type of system that they understand. They do it with a standardized methodology that Project Haystack defined and agreed on.

So far, that methodology has allowed working groups to come up with descriptive tags and taxonomies for virtually any piece of equipment, censored devices, et cetera. So, that's the background. Now, we produce a magazine twice a year and run an event every other year - but it's all still on a volunteer basis and open source driven.

**LM:** Why did you decide to go open source? Was it just to get the problem solved globally faster?

**JP:** In the world of software, big crosscutting problems are now being solved by open source initiatives. You have to get input from constituents across industry with different levels of knowledge. No one manufacturer/developer could know it all.

It became clear that it would be best served by the open source methodology and the open source culture. Come help solve this problem, come participate, voice your concerns, bring your knowledge, et cetera. So, I think at the time we saw the problem and it became obvious that these are the types of problems solved by an open source initiative, which gives a foundation that everybody can use – and then companies build value-added, commercial solutions on top of it.

This was a costly problem, but not one that had its own commercial value because it had to be solved across the board.  Like HTML, you don't pay for HTML, but you might pay for a software application that uses it.

**LM:** Are there any downsides to going down that route? Do you ever get in a position where it's a too-many-cooks situation because everyone, everywhere can get involved with it?

**JP:** There are downsides and challenges to open source, but that's not the too-many-cooks problem..

Open source has not been, historically, a big part of the controls and automation industry – in both commercial controls and industrial. So surprisingly, while in the world of software, open source culture and methodology are understood. When we introduced it, it was fairly foreign. What we've found is the bigger challenge has been getting participation and helping people understand that nobody's going to hand to them and that they've got to join in.

There had been a tendency to look at standards or organizations as something that's going to hand down the answer to you. Open source doesn't work that way. We come together to solve problems, propose answers, debate them, come to consensus, publish it.

And there is still to this day, a large portion of people who would say 'just tell me the answer'. Just to generalize here, but I'd be like: I don't know the answer for boilers. I'm not an expert on boilers. You are, you come and help us. And that has been new and that's one of the challenges; getting the participation because your work is involved to do it.

We have a couple of thousand people who signed up as part of the organization and part of the discussion forums, et cetera. But probably 10% of that are people who actively work to solve the problems, define the tagging vocabulary, define the tag and taxonomy, et cetera.

**LM:** And is this a global initiative?

**JP:** Yeah, it's a global initiative with participants from around the world.

There's more concentration in certain areas than others though. I would say the biggest concentration of contributions we've seen has been out of North America and Australia and Oceana. There's a very strong ethic around efficiency and sustainability down there, so we've had a lot of contributions and very active members from that part of the world.

Increasingly, we're starting to see uptake in Europe, and we've held some events over there.

**LM:** With the amount you've mentioned a range of benefits for Project Haystack – one being energy efficiency. So, if this does become standardized, what's the potential here and what sort of impact could this have if it's adopted on a global level?

**JP:** First of all, one of the use cases is to more efficiently analyze energy data and equipment operational data to drive control decisions that are more efficient. That's a use case. It's not the only use.

I want to bring all the data together from thousands of IoT devices, just so I can put it on a web page without lots of work. That's a use case, right? I can interpret what they are. This is a sensor for this, this, a sensor for this. All of that what's called metadata can come in with the actual sensor values and then you can do whatever you want. It can be reporting, it can be analysis, it can be inventorying, it can be to optimize control for energy efficiency - but it's not limited to that.

And while I'm talking about IoT with sensors, devices, equipment systems is great – we have an explosion of devices. But if it takes too much work effort to work with the data from the device, they're just going to sit there, blinking their light. They're not going to give people value.

What is the value of device? It's the data it produces, right? The data is actually more valuable than the devices themselves, but we don't want to hurt that value by making it too hard to work with the data. So, this problem is fundamental to the growth of the IoT.

There are other organizations and efforts in different segments of industry, government and others, looking at this. Our view is that Project Haystack got a head start on this. It's completely open source. It's contributed to by a wide range of people from many domains and industries. And it's a completely malleable and extensible technology model. So, let's just all rally around it and solve this problem - it's not commercial in any sense.

We hope people will come around and rally around Project Haystack, or even a merger of a combination of technology out there. Because if we have a hundred different solutions to this, we don't have a solution to this. We're back where we were. We've got to figure out the metadata for every single individual device or variation.

**LM:** That's fantastic, it's clearly got huge potential. But what are the hurdles to stop this project achieving its potential? Is it a case that you need manufacturers to sign up to consent to work with Project Haystack? Is it that there's a few different projects going on, so the effort is split?

**JP:** So, one is just awareness. If you have a smartphone, you can pull up your smartphone and you can get all kinds of information, right? You don't really think about it. It's just been solved. And so what we've found is a lot of organizations, especially IT groups and others who want to implement IoT solutions and work with all this data, they actually don't realize this hasn't been solved for the IoT. So, awareness is number one because we see people still going and trying to build their own proprietary solution. Why?

Then, encouraging participation – which I talked about before. They just want to be told what to do.

The third one is recognition, which is different to awareness. We know there are numerous major brand name manufacturers using it, who for whatever reason, haven't chosen to put their name and logo on the Project Haystack website to publicly recognize they're using it.

In my role as Executive Director of Project Haystack, it's one of the things that often has me scratching my head. But in the world of controls and automation throughout the nineties and early 2000's, there was a phase we call the protocol wars - where there was a view that one open protocol would solve it all and everybody should rally around only a single one. There were serious battles and manufacturers taking positions for, or against, one protocol.

We believe there's a hangover from that. Manufacturers are afraid to throw in their endorsement with any one solution. Not because they don't think it might solve their problem, but because they're worried that another war is going to emerge and they'll be on the wrong side of it, or it'll be perceived wrong. Then the other is the fact that there's more than one initiative out there. We all started well-meaning and what we've been trying to encourage is people coming together to say, 'hey, how much difference is there between the solutions? Can we bridge those gaps? Let's just work together.'

We worked with one of the major standards bodies in the building industry called ASHRAE: The American Society of Heating, Refrigerating and Air-Conditioning Engineers. They're a major standards body that has been working on this problem and we started collaborating almost two years ago to unify the solutions.

That doesn't mean they might not publish a standard. That's a little different, but it will mean they all match up really well and any translation would be very simple, right? So, we think people could come around and collaborate around methodologies for easy interoperation. Even if there is a feeling there needs to be multiple metadata standards out there.

LM: So, I suppose to finish then John, does the future hold for the project? Where do you see Project Haystack in a year's time, then five years' time and so on?

JP: I would say the activity in the space is actually increasing, which is a good thing. We just released Haystack 4 for public review in early 2019. This is based on the collection of input from users who have been applying it for multiple years over new capabilities, feature sets, new ways to solve the problem, extending the methodology for a more comprehensive definition of what are called taxonomies – the hierarchy of how equipment relates to each other - how energy flows happen across systems.

There's been a tremendous advance in the sophistication of the haystack methodology all while preserving backward compatibility. The other thing we see is more people coming in from different, applications, equipment types, et cetera. The most encouraging thing is the higher level of understanding of the problem.

This is a barrier to achieving the promise of the IoT and the data and value it provides. It is getting solved. The faster it gets solved, the more value society's going to get out of devices, equipment, sensors, et cetera.

This initiative has tremendous momentum. There will probably be multiple standards out there, but I think there'll be easy translation between the dictionaries - as opposed to highly diverse, proprietary methodologies that can't easily be brought together.

We say to the manufacturers that this is something that is just a barrier to all of us, so build your commercial product on top of this solution. It makes it better for your customers and your product will make it faster-to-market because you don't have to solve this in one more proprietary, siloed way. That's also this part of it, like HTML, let's make that a standard, then build our value on top of it.

This was a CM Industrial conversation which you can listen to as a podcast at: **https://www.searchingindustrial.com/media/1067/making-smart-buildings-even-smarter**.

Lewis Martin is a Business Consultant with Charlton Morris Industrial specialising in recruitment within the building automation industry. Experienced working on behalf of many major clients, Lewis possesses the knowledge, skills and specialist network to successfully build talented teams for his clients. Lewis is passionate about his work and finds it exciting to be working within such a booming industry.

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Contributed Article

# Taking Project Haystack and Niagara to the Real IIoT

ConserveIt

"The adoption of newer technologies that have entered our Buildings IoT (BIoT) sector is not a unique occurrence. The Industrial sector has also been adopting IoT technologies, frameworks and mindsets for some time now as well and modern Supervisory Control and Data Acquisition (SCADA) systems. The IIoT is akin to our BMS/BAS installations and can leverage much of the work we've done on open protocols and standards in the IoT space."

## What is the "real IIoT"?

IoT is an acronym that has become a standard part of our vernacular in the Building Automation industry. Indeed, this acronym has permeated many industries and often a prefix adorns the original acronym in an effort to identify the scope of reference when saying "IoT". The adoption of newer technologies that have entered our Buildings IoT (BIoT) sector is not a unique occurrence. The Industrial sector has also been adopting IoT technologies, frameworks and mindsets for some time now as well and modern Supervisory Control and Data Acquisition (SCADA) systems. The IIoT is akin to our BMS/BAS installations and can leverage much of the work we've done on open protocols and standards in the IoT space. So, what exactly am I referring to when I talk about the "real IIoT"?

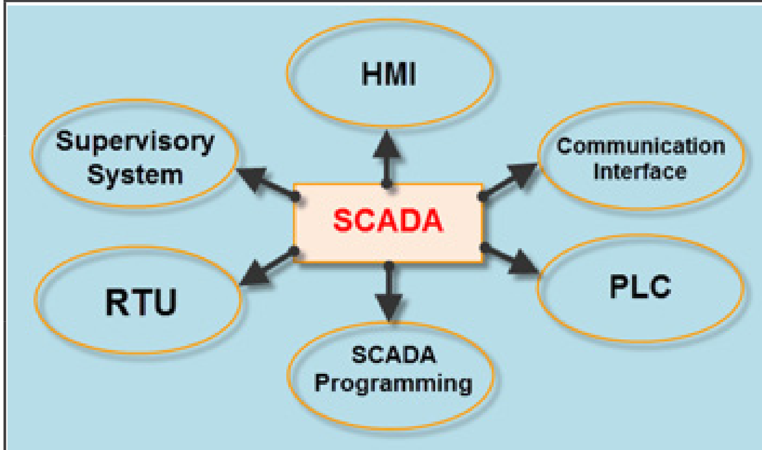
I view Industrial IoT (IIoT) spaces as involving the following types of industries:

- Manufacturing
- Food and beverage production
- Utilities (electricity, water and gas) generation, distribution and management
- Oil and gas production
- Transportation
- Mining

One of the unifying artifacts in the application of control systems in these industries is the use of SCADA systems. Even though it may be an over-simplification, a SCADA system is synonymous with a BAS in our world and it is on this part of the IoT technology space I would like to focus on in this article.

## Brief Anatomy of a SCADA System

Ironically, when looking at what a SCADA system is, it is easy to recognise components in a SCADA system that a BAS would have.

<table>
<tr><th></th><th>SCADA</th><th>BAS</th></tr>
<tr><td rowspan="4">

<br>Source: https://www.watelectronics.com/scada-system-architecture-types-applications/</td><td>Supervisory System</td><td>Web Supervisor or Head End</td></tr>
<tr><td>PLC</td><td>Zone Controller, Area Controller (JACE)</td></tr>
<tr><td>Communication Interface</td><td>Driver</td></tr>
<tr><td>HMI</td><td>Browser Interface/UI</td></tr>
</table>

Also somewhat ironically, SCADA systems have developed, in the architectural sense, in a similar way to the BAS world. The SCADA community has had a similar journey from centralised to distributed control systems, proprietary versus open protocols, vendor lock-in and now the advent of IoT technologies and architectures. These are all familiar discussions to those who have worked in the BAS market for a while. However, what is interesting is that when examining recent advancements in the IIoT space industrial control and automation systems seem to be moving ahead and adopting modern IoT architectures. They are also developing these approaches in an arguably more progressive fashion than that of the BAS market.

## MQTT

Message Queue Telemetry Transport (MQTT) has established itself as one of the key components of many IoT systems. With its focus on reliable messaging, simplicity and scalability it is uniquely suited to address many of the challenges of IoT solutions. One problem remains with MQTT that has not been solved since its initial invention. In the BAS world many organizations, including Project Haystack, have gone to incredible lengths to not only define the protocols by which data is transferred but also the contents (payloads) of the messages. Whether it be sensor types, device profiles or more we are, in many ways, fortunate to have technologies at our disposal that ease the deployment of systems. Yet MQTT does not define the contents of a message. MQTT is purely a transport layer protocol and it does not care what the contents of each message are. There is a remarkable closeness in this property of MQTT with other web standards and technologies. For example, Hypertext Transport Protocol (HTTP), the protocol that transfers web pages from a server to our browser, has this same property. HTTP does not know or care of its payloads when transporting messages from client to server and back again.

The fact that MQTT doesn't define a standard for its payloads is both a feature and a hindrance to its use. The lack of definition offers flexibility and the opportunity for many different applications to use a standardized transport protocol for messaging. On the other hand, the lack of definition for payloads creates problems for multi-vendor integrations. Project Haystack by default offers the possibility for standardizing the payloads for MQTT messaging by using one of the already available encoding schemes for tags, such as ZINC or the Project Haystack JSON encoding definition but the use of ZINC or JSON can be problematic for highly distributed IIoT applications where connectivity might be over low bandwidth technology and very expensive. In this case it is important to reduce the payload size through the use of binary encoding with a well-defined and standard format. This is the space the SparkplugB standard occupies and it is particularly suited to solving the problem of MQTT not having a standard payload definition as well as keeping payloads compact through the use of a binary encoding.

## SparkplugB

SparkplugB is an application layer specification for the standardization of the MQTT topic namespace, device state management, and the MQTT payload. Originally developed by Cirrus Link founder Arlen Nipper (also one of the original authors of MQTT) SparkplugB is now an official project being guided by a group of companies under the umbrella of the Eclipse Foundation IoT project and is under active development for organizations to adopt. The key feature of interest to Project Haystack is the standardized payload definition. The topic namespace and device state management are also very useful but in the context of transporting Haystack tags it is the payload that is most useful. The SparkplugB standard defines a binary encoding using Google Protobufs (https://developers.google.com/protocol-buffers). Protobufs allow developers to define a message format through a simple declarative syntax and then have those message definitions compiled into source code that can be used by an application to generate messages. Protobufs supports the compilation of message definitions into a number of popular programming languages. SparkplugB uses Protobufs to define a standard binary encoding of messages that will be transported over MQTT. The messages have a number of attributes that allow the publication of things that we might be interested in.

Each Sparkplug message contains a Payload. Each Payload can contain one or more Metrics, a Metric being a value or piece of information being published. A Metric could be synonymous with a Control Point in Niagara for those familiar with that system and like a Niagara Control Point a Metric can be one of a number of different types. In fact, the Sparkplug standard defines around 20 different data types. A Metric is quite useful, but the real magic comes when diving further into the structure of a SparkplugB Payload containing one or more Metrics. The most useful aspect of a Metric is the possibility of adding a set of properties to a Metric, suitably named a PropertySet. In SparkplugB a PropertySet is a list of key/value pairs, a concept that Project Haystack practitioners are highly familiar with.

By using the SparkplugB standard, it is now possible to encode and decode Project Haystack tags for a particular data point (or Metric) and send them over MQTT in a well-defined way with open-source libraries in well-known programming languages such as Java, Javascript, C and Python.

### Sparkplug for Niagara

Through recent work with partners in the electricity sector, to enable Demand Response for better electricity

grid management, Conserve It has developed a Niagara 4 integration module that allows System Integrators to connect in Niagara Control Points to a Sparkplug Service and in turn this data can be published over MQTT using the SparkplugB standard. This new integration not only transmits the raw Niagara Control Point "value" it also collects any extra attributes about the point. Implied tags are collected as are tags explicitly added by a System Integrator. These are then automatically included in the Sparkplug Payload under each individual Metric enabling the tags on each Control Point to be transmitted, using a standard binary encoding, over MQTT.

By developing this integration in Niagara 4 new applications can be opened up to integrate data in a meaningful way in other markets or a simpler method of integrating distributed buildings can be established by using MQTT. There are further advantages of using this methodology. Inherently, MQTT is a "push" protocol. This means that it only requires an outbound internet connection and there is no requirement to open up an inbound TCP port through a firewall or router. Also, by including the tags configured on a Control Point in each SparkplugB Payload, any changes to the tags will be automatically pushed up to the MQTT broker and can be consumed by any application subscribing to the messages coming from Niagara.

## Cloud Reference Architecture for Project Haystack

The Project Haystack community has put an incredible amount of work into the open-source project as it stands today. Semantic models and tags exist for a variety of systems and equipment, a well-defined REST API for transferring data between Haystack compliant systems, open-source software implementations in multiple programming languages and a number of products are on the market today that use Project Haystack technology. One area the community is yet to focus on is the best way to implement a cloud solution for Project Haystack systems. Whilst in some ways doing this is the "secret sauce" many in our community bring to their clients, it is difficult for those new to our community to get started and run up an end-to-end system. Cloud technologies now exist that make the testing and development of these solutions much easier and, by providing something back to the community to enable a quick startup in our space and demonstrate an end-to-end solution, we enable more solutions and greater adoption of Project Haystack.

Project Haystack has always been an open, extensible system of conveying semantic models and metadata. It has found popularity and significant application in the Building Management and Automation markets, but this doesn't mean it cannot be promoted and used to deliver new and exciting applications in other industries. By leveraging and combining 3 significant open standards (Project Haystack, SparkplugB and MQTT) scalable and reliable infrastructure can be enabled to manage the large amounts of data coming from all types of facilities, not just buildings. Furthermore, by delivering a reference implementation for cloud-based solutions our community can further our goals of an open and interoperable world where data can be exchanged and managed, and value delivered back to our clients. Shortly I will be announcing a new open-source project that will be available for our community to use and to contribute to based on using Project Haystack, MQTT and SparkplugB for the implementation of device-to-cloud solutions.

As the Chief Software Architect at Conserve It, Richard McElhinney manages and drives the development of their industry-leading chiller plant optimization technology and associated products. He also serves as Vice President on the Project Haystack Board of Directors.

# Finding Our Way: Take the Established Success Path for Implementing Building Analytics

buildingfit

**"While many Building Automation Systems (BAS) products are becoming IP-compliant, many existing buildings have older legacy and proprietary BAS systems. This creates big problems for those charged with managing buildings. Semantic tagging is a key part of the solution."**

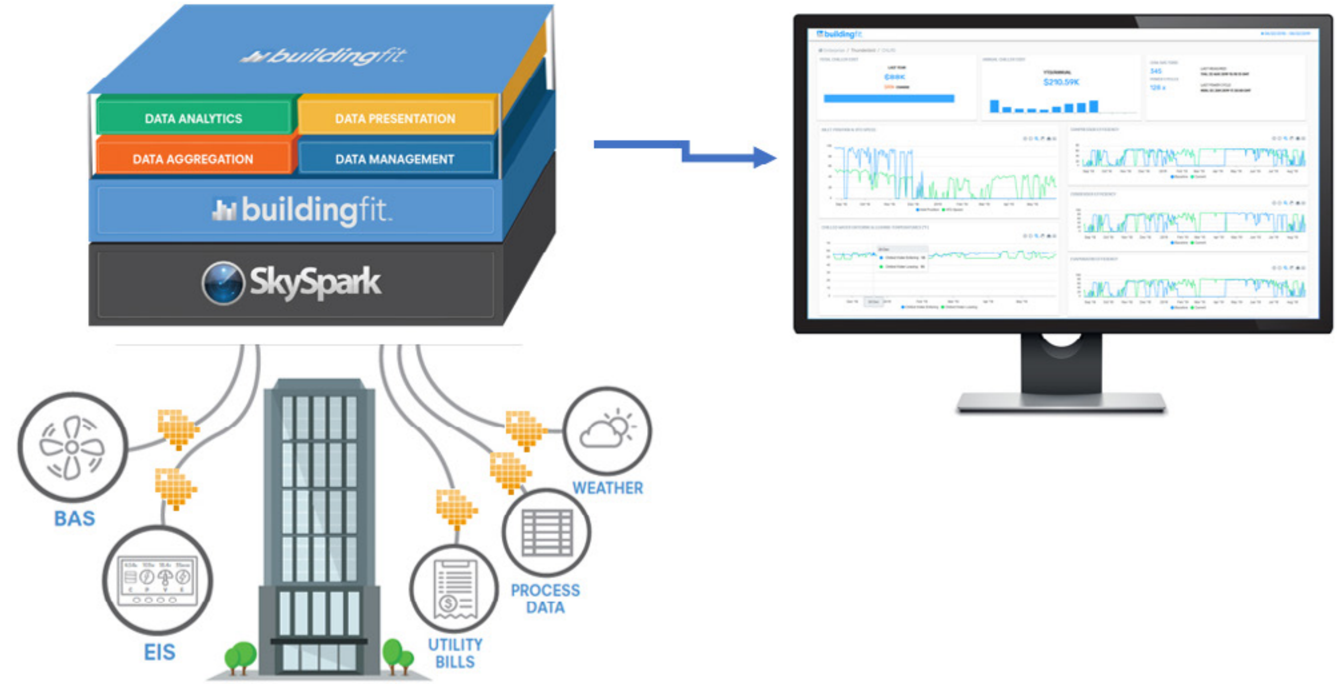
I sometimes feel stuck in the past regarding building automation systems (BAS). This is because I hear a consistent grievance from building owners, their engineering staff and service providers who share the same set of problems. While most industries have adopted and are aligned with industry standards relating to IP networking and enterprise data management, building automation is stuck in catch-up mode. Owners understandably want to manage their sites with the latest technologies and information management systems. While many building automation systems (BAS) products are becoming IP-compliant, many existing buildings have older legacy and proprietary BAS systems. This creates big problems for those charged with managing buildings.

The result of this is that applying analytics on building performance, building owners are locked into a cycle of needing to upgrade outdated BAS while knowing that outright replacement and attaining the capital needed to justify ROI are often insurmountable. Many of these BAS are incapable of offering much more than simple trend data and weren't designed to provide any real operational diagnostics beyond basic alarms.

## When BAS Deficiencies are a Legacy

Operators of older, legacy BAS face a major impediment: They're working with systems that don't easily share information, generally lack the ability to communicate with other systems, and upgradability is restricted.

These factors in concert, present a common challenge: How to view and use different system source data in one unified software view? Many facility managers try to function in an environment in which they can't see how each system is performing and how they interoperate. In addition, many of my customers have administrative and compliance reporting requirements that demand real information and analysis about energy, costs, and regulatory compliance. BAS hold much of that, but unfortunately, not in a manner that allows them to access it, let alone actually use it.




## Modernizing Legacy BAS: You don't have to Hit "Reset"

So, the refrains we hear include: "How do I modernize my legacy systems? And how can I elevate BAS capabilities to get me what I need, while preserving the investments already made?"

Another challenge: How to make necessary upgrades to existing assets that make the data accessible and usable – all without breaking the bank? Serving that data up into a single information and analytics platform is the next step.

Integrating the right data analytics tools to access these insights is a long-standing source of frustration for building managers. Compounding the angst is the advent of Internet of Things (IoT) technologies that offer opportunities for enhancing operational performance but add additional, integration issues.

The result of all this is that building managers are forced to tend to systems individually. It's wildly inefficient and ineffective as technicians limit their operational scope to a singular system rather than gaining a holistic view of how these systems operate in unison and what adjustments can be made to achieve greater efficiency. No system operates in a vacuum. These systems are interrelated and need to be treated accordingly.

While smart systems are the ideal launching point for building managers to make necessary adjustments within their facility operations, this isn't sufficient to provide the insights into how, where, or when to integrate such improvements. Building managers need systems that communicate seamlessly and display essential data in a uniform and meaningful manner.

## Standardization is the Key to the BAS Castle

The good news is recent advances are lowering barriers to implementing analytics. In days gone by, building systems were simply gathers of data, making it available for facility managers to analyze. The problem is that each data set tends to speak its own language. While it may be easier to access the information today, building managers are missing the ability to review it unitarily and use common metrics to make impactful decisions.

Thankfully, significant progress has been made to solve this problem. A great example is the Haystack schema from Project Haystack that aims to standardize semantic data models and simplify interpretation of data collected across operational systems. Professional analytics tools, like my company's BuildingFit™, have further demystified the puzzle of how to achieve greater energy efficiency through technological features. For example, the BuildingFit preferencing tool is powerful because it uses machine learning to standardize diverse data across different platforms. This approach normalizes data points to enable "apples-to-apples" comparisons, ultimately unifying system data into easy-to-understand insights.

This approach to standardize data and analytics helps facility management make smarter decisions and make them faster. As an example, it enabled Banner Health to leverage facility data that yielded a cost savings of $3.8 million in annual energy savings across a multitude of facilities.

## Leveraging Service Providers and the Secure Cloud

Enlightened facility managers are taking advantage of two market trends to accelerate the successful implementation of smart building technologies. Many are realizing a quick and effective way to adopt analytics in their facilities is partnering with competent service providers with a focus on providing building analytics solutions. Innovative energy engineering, commissioning, and systems integrators, in turn, are providing data analytics as a core service offering. Meantime, enhanced security software tools allow cloud access to dashboards and building data that keeps information secure while providing increased access to building operations across geographies and diverse team members.

## SaaS Lowers Barriers

There are significant benefits by working with an analytics vendor with a software as a service (SaaS) model. With SaaS, instead of paying for expensive, upfront licensing costs, users pay a lower subscription fee. With software costs spread over time, users see a much faster ROI. This model offers other benefits, such as automatic and easy software upgrades and improvements, which are usually included with the subscription. Many of the barriers of implementing data analytics software are simply removed with SaaS.

## Getting it Right

Looking into the future of smart systems and buildings, the myth that needs busted is that meaningful data analysis requires individualized attention to each facility system. To get it right, the appropriate software platform that proactively standardizes the data collected across systems to make analysis more readily decipherable and actionable must be chosen. Those that recognize this will reap significant benefits later.

It's not our technology that's trapped in the 20th Century. The good news is, we already have an established path to success. We can overcome the lack of standardization surrounding BAS technologies and the data they present that make us feel like we are still dreading the Y2K bug. If you follow the model of embracing a standardized approach to data analytics, leverage service providers, and rely on the secure cloud, building managers can effectively modernize legacy systems and make more decisive and cost-effective decisions in their facilities.

Rob Glance is Vice President Information Technology of BuildingFit™, a smart building data analytics software company. With more than 20 years of experience in energy engineering and management in information technology, Glance has dedicated his professional career to problem solving through smart technologies.

Contributed Article

# The Haystack Byte Journey Continues

**"Haystack's journey continues from where we left off. Haystack's primary capability is that it can act as a server and a client."**

Haystack's journey continues from where we left off. Haystack's primary capability is that it can act as a server and a client. This feature enables the creator to utilize as a converter technology of data types from various sources such as images, personal feedback, sensors, input-output from controllers, and others.

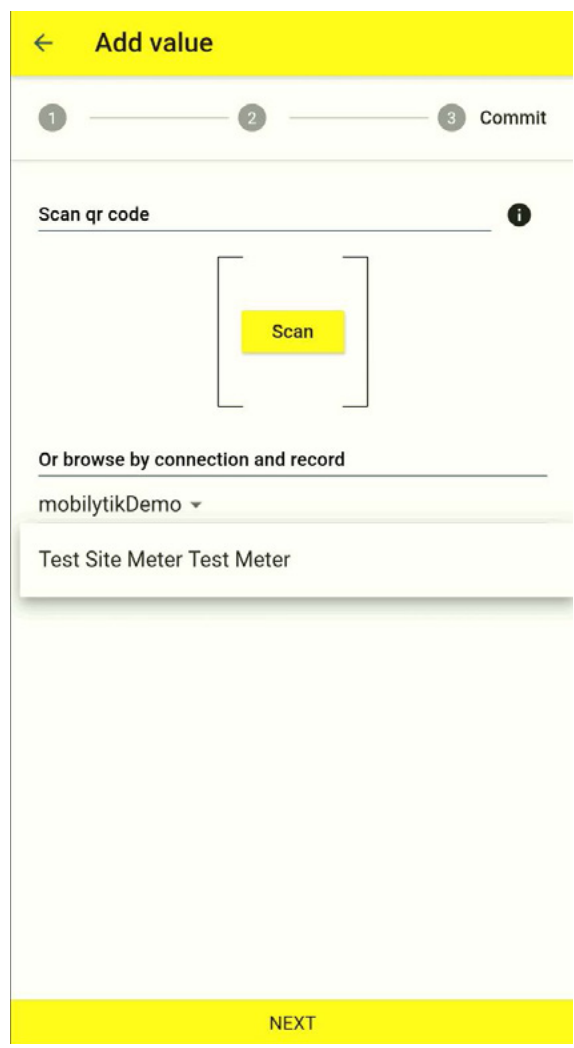
Within the last article, we mentioned Project Sandstar, which is a hardware-agnostic DDC. Project Sandstar merges the Sedona framework with Project Haystack into a seamless whole.

Also, in the last article, we had mentioned a product called "Mobilytik." We have improved this application to have offline power metering and personal feedback feature.

Haystack byte can be hiding in different locations and different forms. The byte could be lurking in an image or a video feed or within voice form. We can derive this byte and encapsulating it so that we can pass the data to the Haystack server.

## Offline Meter

We have generated a new feature called offline meter. There are cases within facilities where budget constraints do not allow for managers to install a digital meter that has BACnet or Modbus protocols capability.



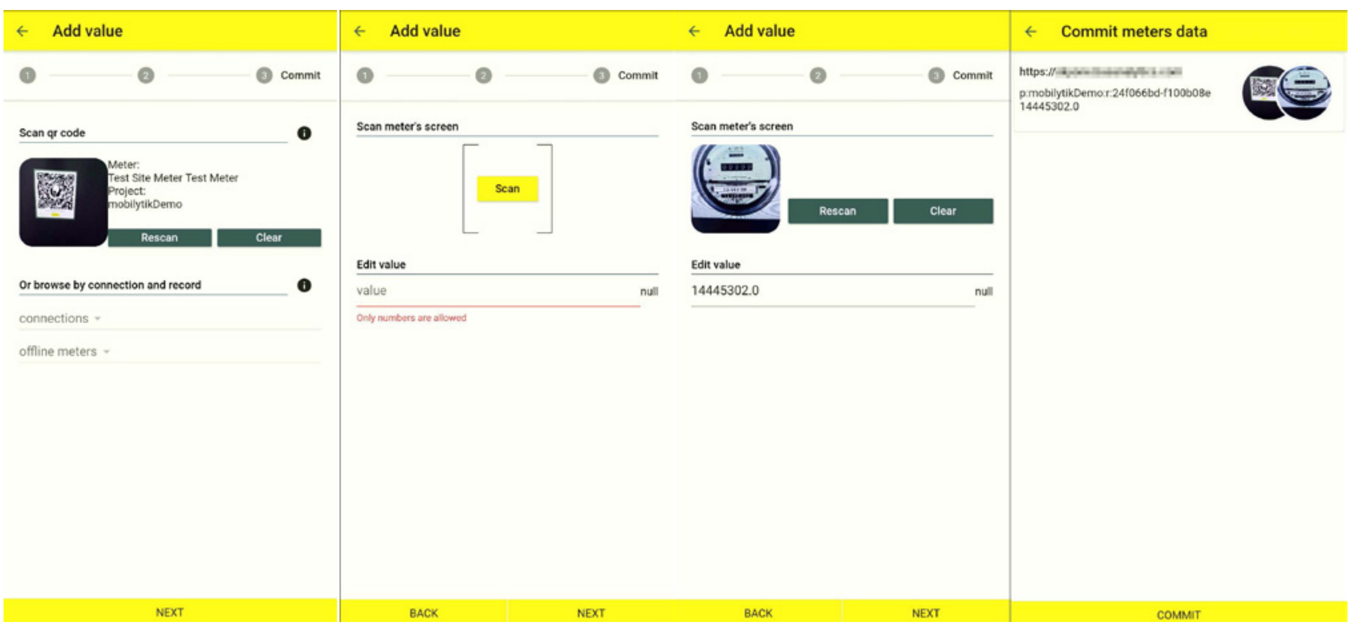

Within "Mobilytik," we have generated a feature where the facility technician can derive the current meter value and upload it to the Haystack server.

The facility manager can easily find the virtual meter points based on the barcode. Mobilytik generates the barcode from Haystack's id tag. The engineer adds a simple Haystack tag called offlineMeter to the Haystack record within the Haystack server.

When the end-user logs into the Haystack server for the first time, offlineMeters points are cached. The end-user can either select the meter manually or can scan the barcode that is attached to the meter.

At this stage, we can take a picture of the analog meter. Google's tensor-flow machine learning algorithm helps us to parse the image and digitize the text.

Next step, we generate cached data to be committed to the Haystack server. Power meter could be in a location where the is no internet connectivity. There could also be more than one meter within the basement. The system allows committing all historical data changes in one click.



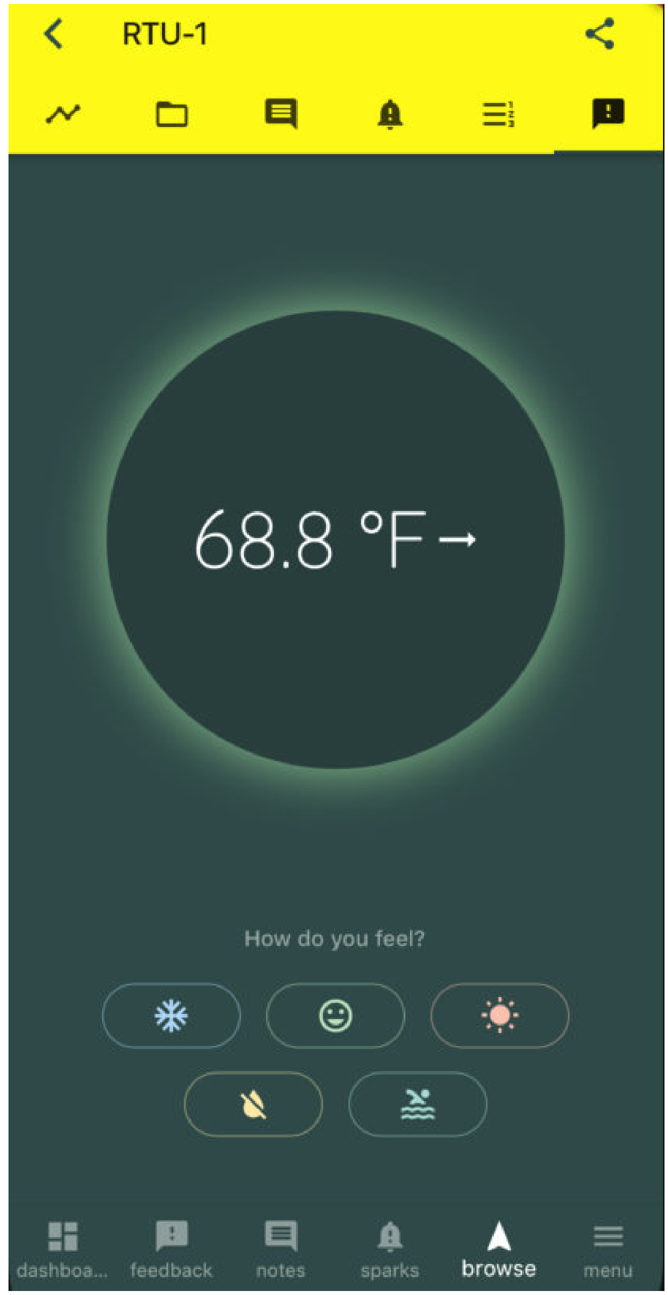
## Personal Feedback

The goal of this feature is to automate the tenant feedback and apply corrective behavior within controllers automatically. Equipment of end-user defined as a tag on the user record. This tag defaults the GUI correct equip.

The GUI contains buttons such as cold, warm, hot, and humid. When the end-user click to the button widget, the application generates a record along with the historical data for the end-users feedback status.

The engineer can utilize this historical data to automate the optimization equipment's run-time. With Project Sandstar-based controllers, automated changes to temperature setpoints will help tenant happiness.

Engineers could also create portfolio-level feedback reports. Feedback KPI reports will help facility directors to optimize tenant happiness as well.




Alper Üzmezler is a Managing Partner of BAS Services & Graphics, LLC, an innovator in Building Automation Technology and BAS Analytics delivery that reduces implementation and facility management energy costs.

# What's Next in niagara4

Niagara Framework® is the open integration platform that master integrators of smart building systems prefer for harmonizing the control systems and digital data sources that contribute to achieving performance goals and occupant comfort. To earn the continued support of the large Niagara Community of partners and customers, Tridium keeps improving Niagara 4 in terms of data visualization, rapid deployment, edge control, physical and cyber security, connectivity, certification and IT compliance.

- **Tag-Based Graphics & Analytics**
- **Fast, Easy Provisioning**
- **Cyber Defense**
- **Edge Intelligence**
- **Connectivity & Cloud**
- **Certification & Compliance**

Easier, more automated and more flexible ways to apply and use semantic tags is a constant focus. In the upcoming 4.10 release, we will be introducing a new browser friendly HTML5 tagging editor which will significantly improve your workflow and user experience. Current Niagara customers and developer partners can apply to our beta program for early access to Niagara 4.10. Others can begin their journey to Niagara at Tridium.com.

TRIDIUM
www.tridium.com

Contributed Article

# Enabling Plug-n-Play Small Buildings Using Haystack Tagging

J2 INNOVATIONS
A Siemens Company

**"We've seen over the past few years, simplifying how smart controls are deployed is transforming residential controls. To achieve a similar transformation in the commercial small building segment, the use of plug-n-play intelligent devices and software applications that just work "out-of-the-box", is necessary to achieve cost-effective solutions."**

While the traditional Building Automation System (BAS) manufacturers have focused their attention on larger buildings, the smaller floor area, less complex building segment of the market has been under-served. There are multiple reasons for this. Per site, the energy bills are lower and the properties are mostly on short leases, so building operators are reluctant to invest much in controls and if a separate specialist contractor is required to install them, the paybacks look less attractive. However, collectively this segment is a significant energy consumer, accounting for around 40% of the commercial building sector energy costs.

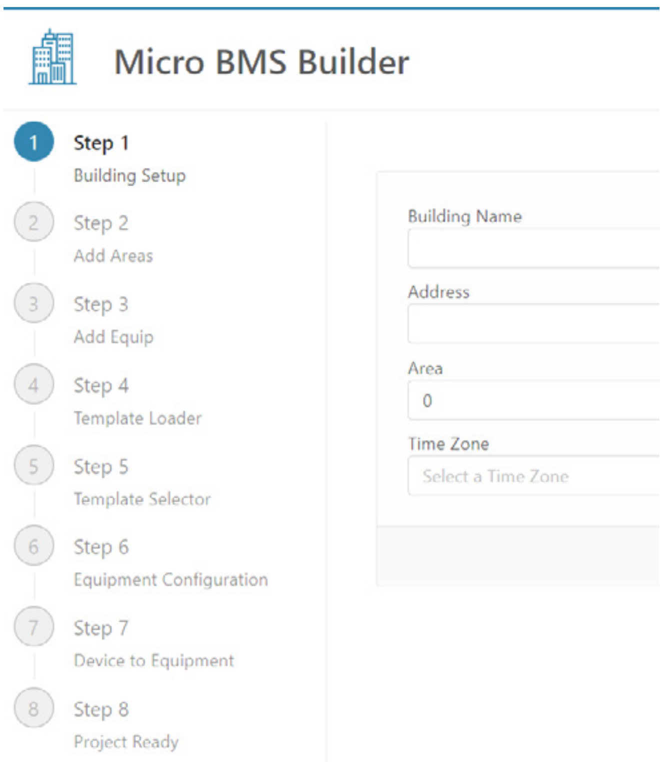
To change this situation, a non-traditional approach to BAS is required. We've seen over the past few years, simplifying how smart controls are deployed is transforming residential controls. To achieve a similar transformation in the commercial small building segment, the use of plug-n-play intelligent devices and software applications that just work "out-of-the-box", is necessary to achieve cost-effective solutions. As there is a significant diversity of device types that need to be handled by such a micro-BAS solution, Project Haystack tagging used to define a template for each connected device, is essential to enable devices to self-describe themselves to configuration wizards which then enable rapid integration of multiple subsystems into a complete solution.

## Small Building Market Opportunity

The commercial building market segment includes small-to medium-size buildings that are often referred to as the "mid-market". Examples of these types of buildings include local government buildings, small offices, leisure sites, small retail, and restaurant premises. Such sites are typically maintained by mechanical contractors who have limited controls expertise, so any viable solution has to be very simple to install and commission. Reducing the cost of secure remote access is also a key issue to solve, as conventional VPN and cellular connection options add to the cost and complexity. Being able to remotely access the control system and its data and alarms offers many operational benefits. It is neither realistic from a skills perspective, nor cost-effective to use traditional BAS products on the majority of such mid-market buildings, which accounts for the limited penetration of BAS and the typically poor level of control, resulting in much wasted energy. The standardization of metadata, as Project Haystack is achieving, and the definition of an IoT-oriented, open standard protocol such as Haystack over REST, can dramatically change the potential in this market segment.

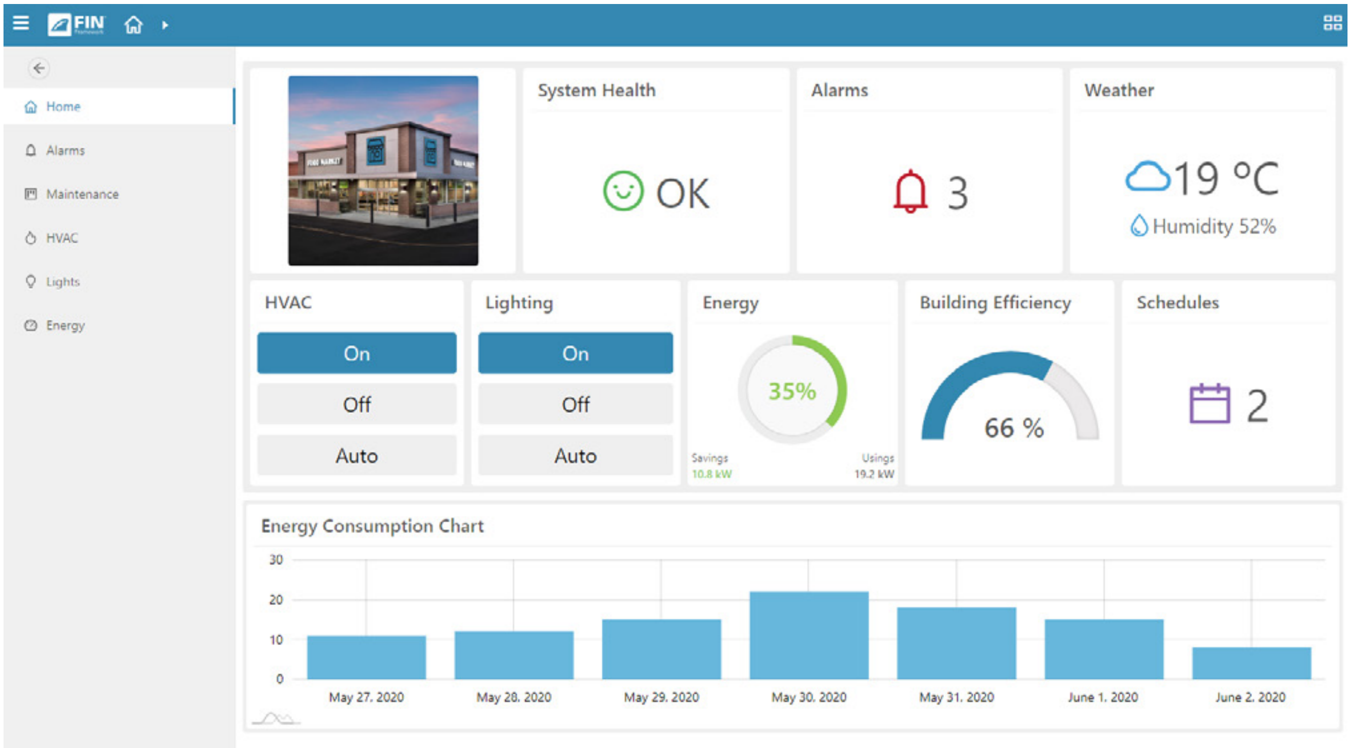
## Small Buildings Can Be Smart Too

Although we have said that smaller buildings are less complex than large offices, hospitals and campus type projects, they do also have multiple subsystems such as air conditioning, heating, lighting, VRF, energy monitoring, solar, and more. The integration of these subsystems can offer both energy efficiency and operational benefits. The opportunity for building managers and owners to have a unified building management system much like their larger building counterparts, is very beneficial if it can be achieved in a simple, cost-effective way. By creating an appliance that can be easily configured using step-by-step wizards combined with the use of device templates for all the devices to be connected, simplifies the integration process to the level that local maintenance contractors, without pre-training on the software, could achieve a successful installation. Such “out-of-the-box”, auto-configuring experiences will be much more attractive to contractors and installers. The micro-BAS style appliance will need to auto-generate the user interface, since any manually-created graphics would be too time-consuming and complex for the installer to create. For smaller buildings, a set of simple dashboards will suffice for scheduling, alarming, and system control. These will need to be usable on smartphones, as well as laptops, so responsive HTML5 web pages are clearly the way to go. All this is now possible through smart applications that leverage self-describing devices and their corresponding points.




## Small Buildings Can Be Plug-n-Play with Project Haystack

The mid-market challenge can be solved by leveraging tagging and data modeling that is described in the Project Haystack standard. This new approach helps software applications to dynamically “learn” smart devices and utilize their data. Through the self-describing nature of the metadata, the “meaning” of the connected devices can be interpreted and can automatically generate content. Through the use of tags and their relationships, additional experiences like dashboards are dynamically generated. Tags can also be utilized to automatically bind device data to control routines. Project Haystack helps enable this “just works” functionality and offers a smart solution for the mid-market.

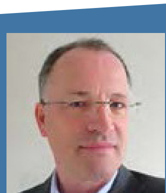



## Small Smart Buildings Can Be Connected Too

As more and more small- to medium-size buildings become integrated and intelligent, getting them connected can bring additional value. Fully encrypted, multi-factor authenticated internet connectivity technology can now be applied to connect smart buildings, to enable remote access and the linking of site data to cloud applications.

Through the use of open protocols, such as MQTT and Haystack, the full value of mid-market big data can be realized.

In summary, by taking an appliance approach and leveraging Project Haystack, the big power of a BAS can be transformed into a software solution that "just works out-of-the-box".



Scott joined J2 Innovations as a partner in 2011, and is now Vice President of Customer Experience. He is well known as an industry expert in smarthomes and smart buildings, is a past president of ASHRAE, and is currently a board member for Project Haystack.

Contributed Article

# The Future of Building Control – Rule-Based or Predictive?

Pacific Northwest NATIONAL LABORATORY

BUILDING INTELLIGENCE GROUP LLC

**"The use of a semantic tagging schema, such as Haystack tagging, is an essential requirement for any system – either rule-based or predictive. Model Predictive Control and its enabling technologies have the potential to provide an even richer trove of data and insights for use by applications ranging from analytics, to fault detection, and digital twins."**

Commercial building controls have evolved from pneumatic and analog electronic controls to the current products which use digital logic - often called Direct Digital Control or DDC. This evolution has largely replicated the functionality of the electromechanical controls with the use of digital logic. Back when we had electromechanical controls the system consisted of sensors for temperature, pressure and humidity. These sensors (in pneumatics they were called "transmitters") provided a variable analog signal in response to a change in the sensed variable. Control logic largely existing inside of a control panel. The logic included various devices that could be used for logic (i.e. a "high select"), as well as receiver controllers that could be connected to one or more inputs and provide an analog signal for an output. The control logic could easily be described in a sequence which stated a series of rules. Here is an example:

*"The economizer shall provide the first stage of cooling when the air handler is operating in the occupied mode, and the outdoor air temperature is more than 5 degrees below the return air temperature."*

The logic can be expressed using a flow chart as follows:

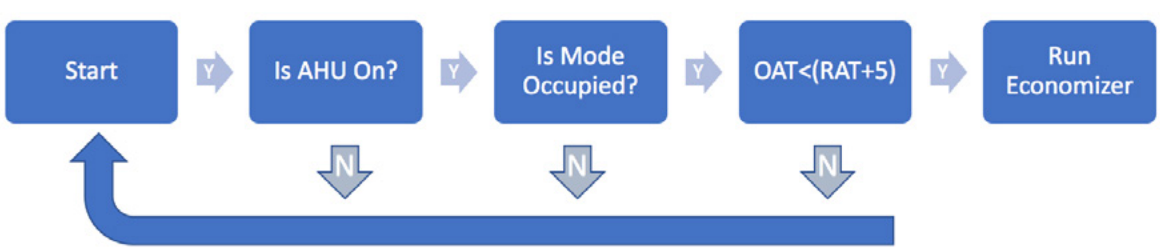



Figure 1. Rule-Based Flow Chart for Economizer

The outputs from the system were primarily analog and connected to valves, dampers, and other actuators. The change to DDC replicated this architecture. Inputs where provided with analog sensors such as thermistors, and outputs went to analog valve and damper actuators. The main change was inside the control panel where there was no longer necessary to connect a series of analog logic devices. Instead, a single controller could convert the analog signals to digital and then implemented the rule-based decision logic in a digital format. Many control programming systems use a graphical format that mimicked the layout and logic of a pneumatic control system — showing lines that connect logical blocks and connecting to blocks for control. There are several benefits to this approach. The primary benefit is that it allowed the industry to transition from mechanical to digital without having to have system designers, and in many cases control technicians need to learn a new system. While most mechanical control implementations used proportional control, the transition to digital readily allowed for proportional, integral derivative or PID control which is provides better accuracy. Other benefits include greater flexibility, more accurate and stable control, and the ability to readily monitor and track operations through a building automation system (BAS).

## Why Change?

From initial actions such as planning, specifying and design, to material ordering, to system implementation and commissioning — there are various steps in a multi-phase construction project timeline that are relevant before a building is open for business. Now, consider that in that project timeline, there are multiple decision makers involved — from the building owner to the design team (which could comprise the consulting specifying engineer, project architect and designer), to the facility manager, systems integrator, general contractor and more.

Rule-based control is fairly simple, intuitive and replicates the process used in industry for decades. It is an effective way to do control, and there is a good argument that it works "well enough". But is that really true?

There are several significant challenges with rule-based control. First, the operation of the system is limited to what has been implemented and deployed in the control sequence. A well thought out sequence such as what is described in ASHRAE Guideline 36, when properly deployed and tested, can be a very effective way to control a system. But a poorly designed sequence, or a well-designed sequence that is incorrectly programmed, can be ineffective and actually imperil comfort and waste energy.

Second, rule-based control systems operate based on current measurements to make decisions. Control accuracy can be achieved by looking at past actions. For example, the derivative factor in a PID loop looks at error over time and modifies the output value to attempt to minimize the error. But this in some ways is like driving while looking in the rearview mirror. We lack to ability to anticipate what is going to happen in the future to the building and the related systems. Rule-based control sequences used for optimization face the same challenge. Strategies like resetting static pressure from the most extreme zones using "trim and response" work by looking at past system performance and tend to be unstable and hard to properly tune.

## Drivers for Predictive Control

We are also at the cusp of a series of new applications that in order to work optimally will need control methods that can accurately forecast future conditions and can optimize future decisions. Here are some examples as to when this would be needed:

- **Passive System Operation:** Passive HVAC systems operate by using the building mass to provide the sensible heating or cooling capability for the building. To accomplish this plastic tubes (PEX) are embedded in the concrete of the building structure. By circulating water through these tubes, the mass can be heated or cooled (often referred to as charged) so that enough energy is stored to accommodate part of all of the load for the next day. For this to work effectively there needs to be some information about the weather for the next day – which is generally available from a weather service. Additional information is needed about how the building will react so that the charging time can be determined and proper setpoint can selected.
- **Thermal Storage:** The use of thermal storage systems requires the ability to decide when to charge and discharge the system. Ideally the system should be charged with adequate capacity for the building to make it through the next day. But to do this accurately one needs to estimate of the capacity of the thermal storage systems and to predict the anticipated load of the building. Today's engineering

practice either uses a "rule of thumb" or simply cools the system to full capacity. Ideally predictive control could be used to look at a weather forecast and then determine the exact capacity needed in the future.

- **Demand Response:** Today many demand response programs take the form of request and respond. The utility provides a signal, and the building implements some form of reaction. As these systems evolve towards true "building to grid" control, there will be a process that allowed the building system to "bid" a certain demand change to the grid operator, there would be a negotiated payment, and then the building would be able to respond providing a specific amount of change in demand for a specific amount of time. Doing this requires the ability to accurately predict the response to future action.

There are projects that have managed to use rule-based control for these applications. But the use is at best awkward and can take trial and error for setup and configuration. Even when successful, just like the PID loop, it may operate better optimized for some conditions than for others.

## Model Predictive Control

Not surprisingly there are technologies that are much better suited to control energy systems in a predictive manner. One such approach has long been used in process industry and is just now starting to be deployed for control of commercial buildings. This technology is often referred to as Model Predictive Control or MPC, but it also goes by other names including adaptive control, data driven control, and artificial intelligence. The concept of MPC is to start by developing a predictive model of the system to be controlled. Ideally this model is detailed, includes key parameters of the system, and captures the response of the system to changes in the driving variables.

In our earlier example of a coil in an air handler, the model might include the chilled water flow rate, the flow characteristics of the control valve, the heat exchange parameters of the coil, the amount of air flow, incoming air temperature, etc.

With an accurate model, it is possible to run a series of iterations that would allow the system to determine the exact timing and position for the control valve in order for the air temperature at the outlet to follow a prescribed signal. This process of choosing the optimal sequence of control values is executed by a "solver", and while it can be mathematically complex, it is a task that can easily be executed by a computer or even by a controller platform.

The use of MPC provides benefits in the ability to more accurately predict future operating conditions of a system and optimize its controls. For the more advanced applications noted above, it is an effective and practical solution, that is difficult if not impossible to deliver by rule-based control.

## Industry Transition

But changing from rule-based control to predictive control is not an easy transition. Building accurate models can be difficult and time consuming and the computing resources needed to run the solver include more processing power and memory than many current generation controllers can provide. Many control technologies are initially developed and applied to demanding industrial processes. MPC is fairly commonly used today for applications in the automotive industry and industrial process control. Over time efforts are made to simplify and cost reduce the technology to the point where it will be readily applicable for commercial buildings.

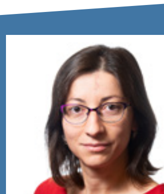
Research is underway to develop both simplified and, in many cases, automated tools to develop the models. Other work is focused on new algorithms for the solvers, allowing them to run faster and with fewer resources than in the past. The end result is that we are starting to see MPC move into the building space. Some of the solutions are coming in as part of new integrated equipment controls that are embedded within packaged equipment. Other solutions may come with the Internet of Things (IoT) controls. There are even innovative startup control companies that have developed their solutions from the ground up to utilize MPC.

## Connection to Haystack

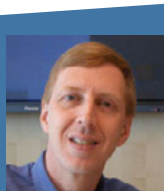
A hybrid approach could provide many of the benefits of using MPC while still leaving the existing rule-based control found in most commercial buildings in place. This is appealing as a transitional strategy to allow for improved prediction and performance, without an extensive control retrofit or replacement. This approach would leave the existing building control system in place and utilize it as a tool for data collection. Predictive models would be developed using information discovered in the building. Once the models are in place, and their performance verified, the application would then use data from the control system along with the model to compute optimal set points. These would then be communicated to the control system which would then operate using its current rule-based functionality. This concept has the potential to provide many of the benefits without having to change what is in place today and could be a viable solution as we transition to broader use of predictive control. The use of a semantic tagging schema, such as Haystack tagging, is an essential requirement for any system — either rule-based or predictive. MPC and its enabling technologies have the potential to provide an even richer trove of data and insights for use by applications ranging from analytics, to fault detection, and digital twins. Finding and connecting to this data in an automated manner requires that information is tagged. Tagging is a key component that will lower the barrier to entry and accelerate adoption of advanced analytics and control methods.

## Conclusion

Given the potential benefits of predictive control, and the fast-paced evolution of its enablers, it is very likely that we will see it broadly deployed in the future. Right now, we are still in the very early stages of that transition, with significant interest in the controls research community and limited application on commercial projects. But the drivers for improved performance from control systems, along with new work coming from the Department of Energy and ASHRAE could change this balance. At the end of the day expect the biggest shift to come in the area of technology solutions. Computer processing capacity continues to improve, and costs continue to decline. The use of cloud computing as well as the introduction of powerful edge computing technology provides significant leverage, and there is extensive research that is ongoing in the areas of machine learning and artificial intelligence. Keep an eye on this as it evolves and look for potential solutions that are ready to for integration in future projects.

Draguna Vrabie is a Chief Scientist in the Data Sciences Group at PNNL. Her work focuses on integration of machine learning and predictive control in support of the Department of Energy.



Paul Ehrlich, P.E., is the Founder and President of Building Intelligence Group LLC. His work is focused on building controls, integration, and improving efficiency of commercial buildings.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Contributed Article

# Resolving Pain Points in Tagging Via the Use of Artificial Intelligence

BRAINBOX AI

**"Automating the tagging process, making it easier to generate manageable data, is the next hurdle. Artificial intelligence offers a way to automate efficient tagging and organize the building's data points."**

Every second, 127 devices are connected to the internet. By 2027, 41 billion IoT devices will be connecting to the internet, up from 8 billion in 2019[1]. All of these devices will be generating massive amounts of data that, if harnessed properly, will deliver better efficiencies, better results and greater opportunity for people and industries everywhere. Frank Bien, CEO & President of Looker, a data analysis tool said, "Data is now fundamental to how people work & the most successful companies have intelligently integrated it into everyone's daily workflow."[2]

Each day, building owners and facility management teams are taking advantage of the many systems, applications and data points that are available to measure, adjust and finesse the performance of their buildings. Over time, the data points become a large data set. The building automation industry is no stranger to the power of big data and has developed tools, protocols and initiatives such as Project Haystack, to help manage and draw insights about the buildings and installed equipment from the data captured.

However, the current process of effectively and efficiently tagging building data points is time consuming, expensive, and ripe for error. Automating the tagging process, making it easier to generate manageable data, is the next hurdle. Artificial intelligence offers a way to automate efficient tagging and organize the building's data points.

In an article published in the December 2020 issue of Automation in Construction, a team of researchers at the National Renewable Energy Laboratory in collaboration with researchers at BrainBox AI published a paper proposing a unified architecture for automating point tagging for BAS data. The unified architecture leverages accessible data available from the BMS such as time-series data, raw data point names and other historical data. This data is then used to teach via machine learning. These learnings are then applied to infer the proper tag associated with equipment points throughout the building.

The paper also presents the results of two test cases where the artificial intelligence "learned" how to properly identify equipment and to tag points in a building with a high degree of accuracy and no human intervention. The results were impressive.

## Why Haystack?

The researchers of the study deliberately chose the Haystack standard for their tests because of its flexible approach to point tagging, which allows data to be easily adapted to standard machine learning tools. The basic Haystack schema classifies three key elements: points, equipment, and systems. By having a clear and concise standard, the individual points can be identified and tagged, distinguishing them from related points within a piece of equipment. Additionally, the Haystack standard has significant industry support and adoption. This support helped drive the decision to build the artificial intelligence around Haystack instead of one of several competing standards.

## Teaching the Artificial Intelligence to Tag

Artificial intelligence and machine learning require significant amounts of data. Existing energy management systems can be used to provide historical data in the form of point data and time-series data. These types of datasets "teach" the artificial intelligence about the equipment and systems within the building. The data is used to identify trends, cycles or patterns that can be used to automate the mapping of the building.

The researchers set a standard of three weeks of building data to input into the artificial intelligence engine, while acknowledging that identifying trends, especially those related to seasonality are important. They determined that "waiting for enough data to account for seasonal trends lessens the value of the automation process" and thus three weeks was deemed sufficient. In addition, due to the fact that artificial intelligence is continually learning, it will adapt to adjust for any seasonality it encounters as it learns the building profile. In addition to the historical data, the artificial intelligence incorporated both rule-based algorithms and machine-learning algorithms. Applying these algorithms to relevant historical time-series data and the raw point data names provided the basis for the artificial intelligence to identify the proper tag.

## Initial Test of Concept: Similar Commercial Buildings

To test the artificial intelligence, the research team looked at three small commercial buildings with similar HVAC systems. The HVAC system, comprised primarily of rooftop air handling units, had been previously tagged using the Haystack standard. After cleaning the data to remove points with insufficient information, each building had between 40 and 60 unique points to be tagged by this automated process.

The learning process required iterations, so data from Buildings 1 and 2 initially trained the artificial intelligence. The learnings were then applied to the data from Building 3. The second iteration ran Building 2 data and the trained Building 3 data through the process, applying those learnings to Building 1. Finally, the data from Buildings 3 and 1 trained the algorithms in the artificial intelligence which was then applied to Building 2. This closed loop model allows for continual learning.

Figure 1. A test of an automated artificial intelligence process successfully mapped 70% of tags correctly at the Energy Systems Integration Facility on the NREL campus in Golden, CO. The experiment on the building included 352 points with multiple AHUs, MAUs and exhaust fans.

Using this iterative approach resulted in the artificial intelligence correctly applying 85- 90% of the tags across the three buildings with a 10% incorrect tagging rate. Combining the iterations of algorithm outputs improved the accuracy of the automated tagging.

The more often a tag appeared, the more often the artificial intelligence would correctly identify the tag. The test also found that points associated with highly unique time-series data such as min/max or humidity tags that may not appear as frequently, were still correctly identified. The artificial intelligence was able to detect outliers and flag those for human review.

## Second Test of Concept: NREL ESIF

The NREL Energy Systems Integration Facility contains 352 points and includes multiple AHUs, MAUs and exhaust fans. Since this was one large facility, the points were divided into 5 approximately equal subsets and the Unified Architecture trained on subsets 1 – 4 and applied to subset 5, trained on subsets 2 – 5 and applied to subset 1 and so on, until all 5 data sets had been trained. In this tagging experiment, "the algorithm produced more false negatives, that is, it did not apply tags that it should have applied." Even with these false negatives, the Unified Architecture was able to apply 70-75% of the tags correctly.

These two experiments provided a high degree of accuracy even with very different building types. Automating the process of applying Haystack tags to building systems can reduce the man-hours required to tag a building. Using artificial intelligence to automate tagging can increase the number of buildings using the standard which can, in turn, enable buildings to better leverage the benefits of smart building technologies and facilitate their adoption and implementation.

Jean-Simon Venne is a Co-Founder and CTO of BrainBox AI. As a technology expert specializing in the fast and efficient migration of technological innovations to commercial applications, Jean-Simon has over 25 years of experience developing and implementing new technology to solve long-standing commercial issues in the fields of telecommunications, biotechnology, and energy-efficiency.


**References:**

1. https://www.vxchnge.com/blog/iot-statistics
2. 2019 Internet Trend Report, Mary Meeker, https://www.bondcap.com/report/itr19/, slide 147

Contributed Article

# Co-Design a New Process to Improve Control System Design and Delivery

Pacific Northwest NATIONAL LABORATORY

BUILDING INTELLIGENCE GROUP LLC

**"The vision of grid-interactive energy-efficient buildings will be realized through effective integration of energy savings and automated demand response technologies enabled by advanced building energy management systems with two-way grid interacting capabilities."**

For many HVAC system designers, specifying controls is one of the most frustrating parts of any project. There may be a last-minute push to get the details for the specifications, points list, sequences, and diagrams completed, before the project can go out to bid. Often that means working with limited time and without enough hours available to put much effort into the design. Working with the control contractor can be a challenge as well, from prices that exceed the budgeted amount to problems with the products, design and performance. After the project is complete, the owner may complain that the controls don't seem to work the way that they expected. It seems like there has to be a better way to design and deliver controls!

If you can relate to this, you should realize that you are not alone. The processes of designing, installing, programming, commissioning and operating control systems are complicated and fraught with problems. In fact, in many ways we are fortunate that we have projects that work as well as they do! Here are some of the systemic problems and challenges involved with controls:

## Control System Design

Most HVAC systems designers have a deep understanding of what is needed to determine loads, size equipment, make equipment selections, layout ductwork and piping, and prepare all of the necessary drawings and specifications needed for a project. But they often don't have the same level of expertise when it comes to controls and may rely on what they used on a previous project, or for help from a "friendly" control contractor to help suggest sequences or provide a specification. It is not unusual for control designs to be one of the last steps in the design process. That means that it is done with little time left before it is "pencils down" and time to submit documents for review and bids. Designers also have few tools available to help with designing controls. Most rely on an existing library of specifications or sequences. They end up re-using what was used for previous projects, and trust that with some edits and tweaks that it will work well for the current project. Designers lack the ability to test or verify that a sequence is effective in the design phase and have to depend on details to be worked out by the control contractor, or during the commissioning and checkout process.

## Control System Delivery

The control design documents provided by the system designer (sequences, point list, diagrams, etc.) require significant interpretation by the control contractor. The contractor initially evaluates the design with the intent of providing pricing. This effort is focused on determining what products are needed, estimating costs for wiring, programming, checkout and warranty, then going through competitive bidding. Once the contractor is selected, they can start on the details of the control design that is reflected in the control submittals. Often this process includes selecting the valves, actuators, dampers and other end devices, as well as the controllers. This is all reflected in a series of submittal documents which are provided back to the system designer for review and approval. The contractor orders materials to manage the installation of wiring and devices and coordinates their efforts with the other project contractors and sub-contractors. Control programming is typically done once equipment is in place, powered, and ready to operate, which occurs very late in the project sequence. The control programmer is responsible to read through the sequence provided by the project designer and determine how to implement it in the control system. This is a very difficult and complicated process, which unfortunately is often fraught with chances to introduce errors during the process of manually interpreting a sequence into a program. The programmer may find that there are issues with the sequence provided or with the designer who may not be clear or a good fit for the project. Programmers may go back to the code that they used for a similar project and will use that as a starting point for this new project. Most control programs provide some limited ability to test out programming before deploying it in controllers, but the real test comes once it is installed. During the installation process, the programmer and other control technicians need to test out the logic to see if it works, tune the control loops, and verify that systems are up and running. The end result is a project that may or may not be representative of what was intended by the designer. There are also challenges during installation with how data is identified.

## Project Commissioning

Finally, the control system goes into commissioning. During the commissioning process, the commissioning agent may review the control design, and carefully test and validate the control system as implemented by the contractor. A series of reports, meetings and changes ensue, and at the end of the day, the system is finally considered to be complete. Not surprisingly, the end result may not be exactly what was intended by the system designer, and the owner may find that the system falls short of their expectations.

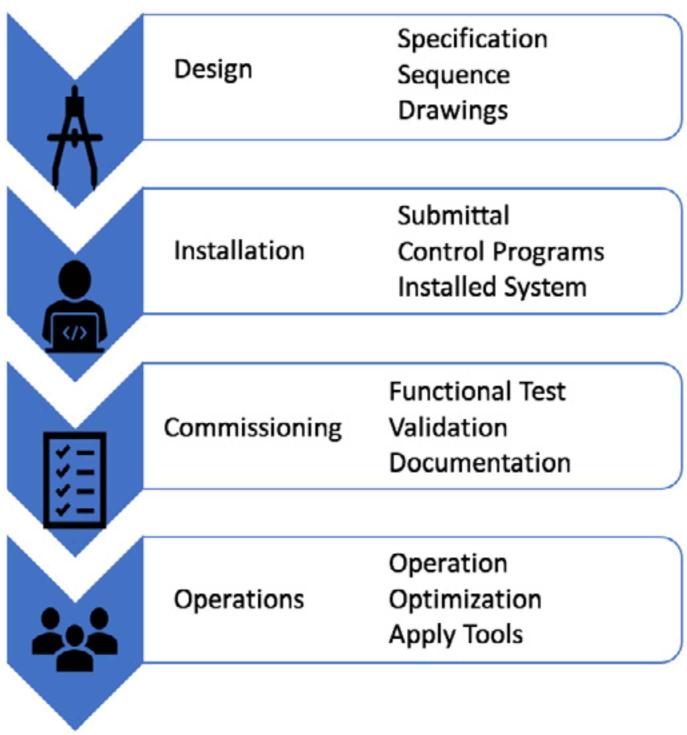



Figure 1. Building Controls Design and Delivery Process

## Process Challenges

As you can see from what was described above, the entire process for the design and delivery of the control system has significant challenges that often end up with a control system that doesn't provide the performance required for the project. Some of the key items to note are:

- **Complexity:** Control design is specialized and complex. Many designers are not trained in controls.
- **Design Tools:** Designers do not have tools to test or evaluate control design.
- **Process Flow:** The control system design is often completed near to the end of the design sequence, and programming occurs near to the end of the construction process. For design, this means that the designer may have limited time and budget, but also that options for controls are not evaluated early in the design, potentially allowing for overall improvements in project efficiency and reduction in cost. The installing contractor also ends up doing some of the most important parts of their work under significant time constraints of when equipment is installed and powered, and when the building is preparing for occupancy.
- **Document Clarity:** The documentation provided for a control design requires a significant amount of interpretation on the part of the control contractor. This is especially true for the sequences where the programmer needs to read a verbose English language description and develop the necessary control programming logic.
- **Documentation and Training:** The system designers and programmers' intents for how the system should be operated are often not clearly communicated to the owner and their operations staff. The end result is owner and operator frustration with the system.
- **Data Tagging:** Requiring the use of a semantic tagging schema such as Haystack as a requirement, and implementing it during installation can save time for the installer, and commissioning agent. For the owner, it makes the use of data analysis tools simpler, faster and more effective to deploy.

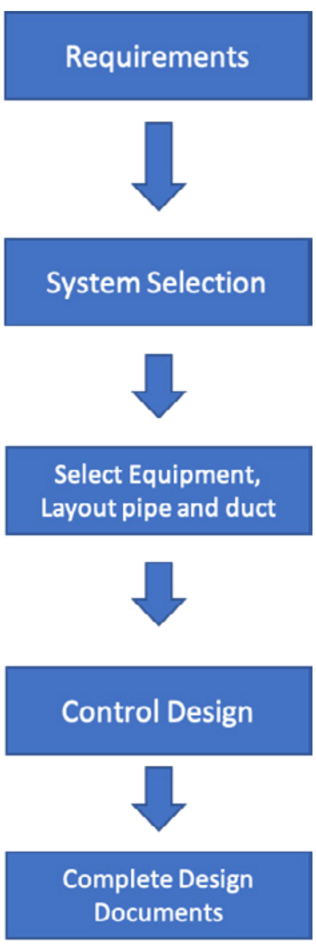



Figure 2. Conventional Sequential Design Process

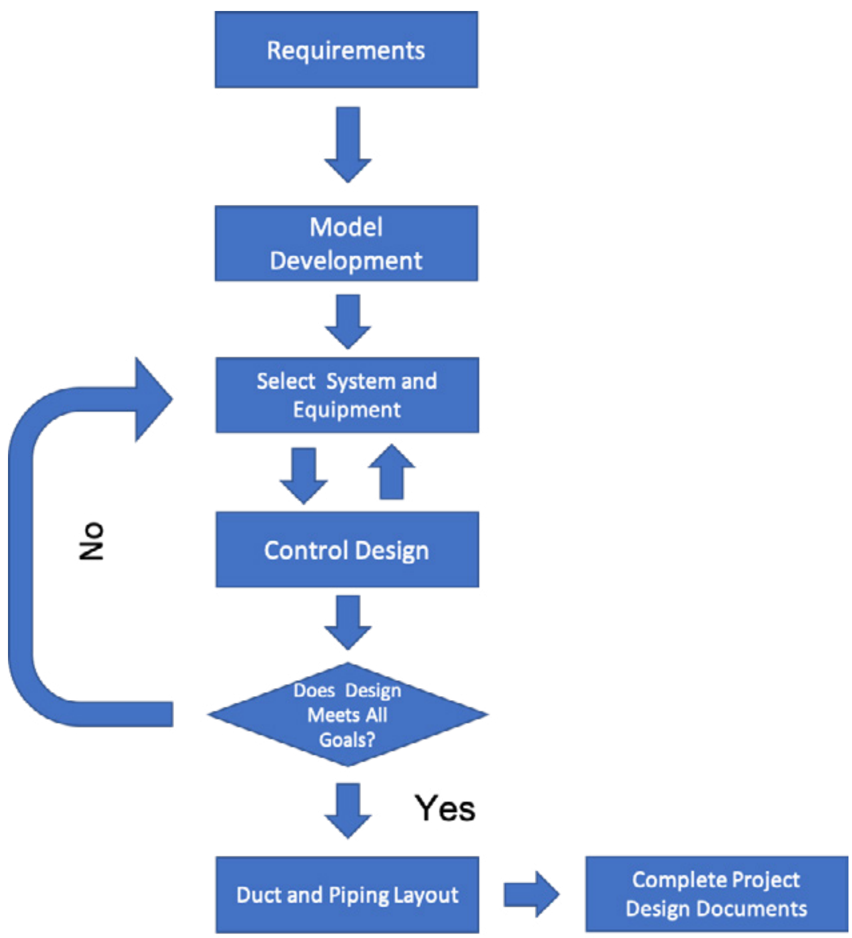



Figure 3. Proposed Iterative Co-Design Process

## Is there a better way?

The challenges with the design and delivery of control systems are a long-standing problem. Changes in codes and standards, and the need to have systems that provide improved energy efficiency and a healthy indoor environment further exasperate these challenges. Fortunately, these problems have not gone unnoticed. Control vendors have provided tools to their branches and system integrators intended to help them to be more productive and efficient. This includes enhanced tools to document, troubleshoot and program control systems. Contractors have also provided programs and tools for designers that range from assisting designers with writing sequences and specifications to providing online tools. Organizations such as ASHRAE have also been involved with the development of guidelines on how to write control sequences (Guideline 13[4]) as well a recommended language for high performance control sequences (Guideline 36[4]). The efforts by vendors as well as the industry work completed by ASHRAE are all important, but they don't really attempt to fix the basic process issues.

The US Department of Energy has recently started work on a series of projects that are intended to provide a path to a more effective process for control design and delivery. These research projects are in their early stages, but they have the potential to dramatically change how controls are designed and delivered, and may lead the way to achieving improved energy efficient and reliable buildings.

### Open Building Control

The Open Building Control[3] project is intended to improve the process of control design and delivery by developing tools and standards that will digitize the process, starting with design through installation and verification. The concept is to start with new tools for the system designer that allow them to select from a library of high-performance control sequences, or to develop their own sequences. The library includes sequences recommended in ASHRAE Guideline 36[4] "Best in Class HVAC Sequences" as well as others. Sequences are developed in a "Control Description Language" (CDL) that allows them to be tested during design and also to be used as part of an energy simulation. Semantic tagging can be readily included

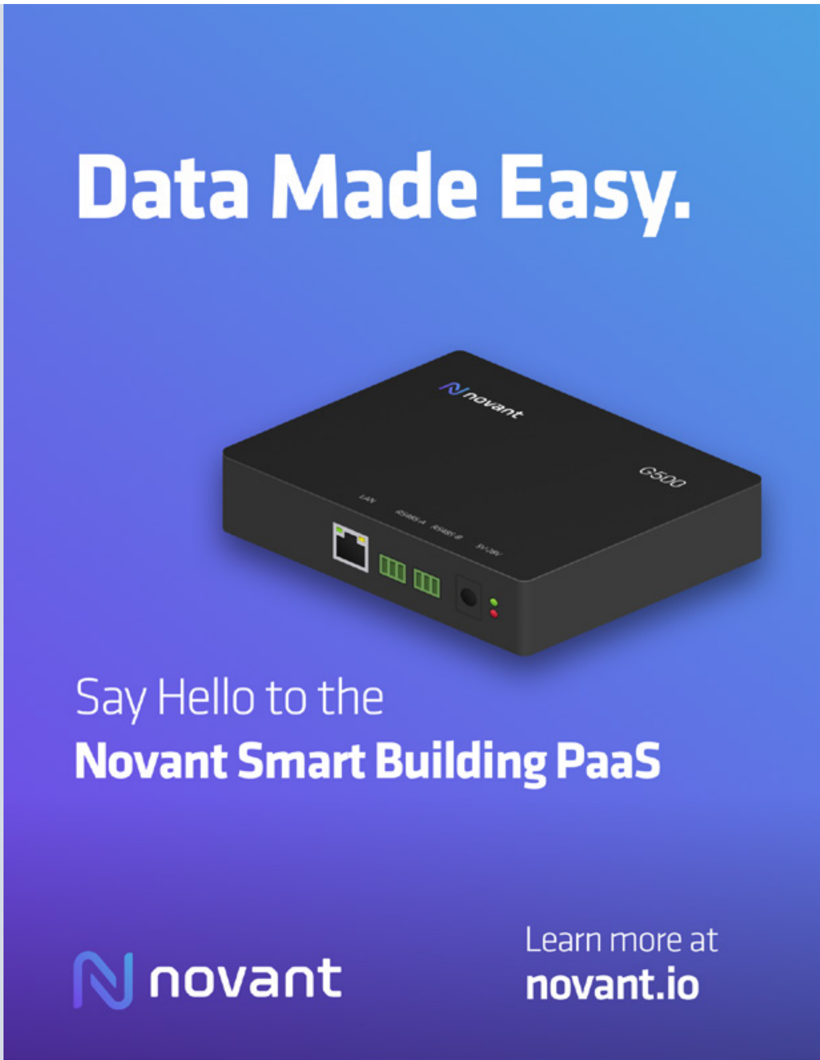


From two-time Haystack Connect keynote speaker, a book that covers key aspects of IoT system design. It provides engineering textbook style treatment of IoT focused topics including:

- Edge
- Communications
- Cloud (including ML)
- Security & Management
- IoT Data Models and Metadata
- IoT Data Standards
- IoT Platforms
- Putting It All Together

A section on Haystack is included in IoT Data Standards chapter. A detailed case study and several examples are from BMS systems.

https://www.iotbook.org



in the CDL, simplifying checkout, commissioning, and data analysis. Testing during design helps to minimize the need to make changes during the construction and commissioning process. The CDL file would be included as part of the control design documents. The contractor can use this file to prepare their project estimates and complete their submittals. When it comes time to program the system, there is no need to interpret a written sequence document. The CDL can either be directly applied for use in the vendors controllers, or it can be translated for use in legacy products. Additional tools allow the contractor, owner, and commissioning agent to verify that the system is operating as designed.

Work on the Open Building Control project is underway at several of the US Department of Energy's national labs. Work has just started in ASHRAE to define the Control Description Language as an ASHRAE standard in Project 231P.

## Co-Design

In other industries including the design of aircraft, automobiles and other complex systems, there has been a dramatic shift in how controls are designed. Instead of designing controls toward the end of the design process, control design is being done as a continuous and iterative part of the design process. This concept is called Co-Design and is the topic of a new US Department of Energy funded project[1].

Here is how the co-design process would be applied to commercial buildings. One of the initial steps of the design process would be the development of a complete energy model that includes the building envelope, as well as all building systems and controls. This model would be used for comparison and evaluation of design options, selection of systems and equipment, and design of control sequences or strategies. The design team might consider a series of iterations or systematic control co-optimization procedure, using the model and various system options, to help determine the system that would meet the owner's goals for first cost, energy, health and safety, demand flexibility and other factors. As the design evolves, the model would continue to be updated. Once the design is finalized, the model can be used to test the control sequence to find if there are any errors in the logic, stability, and output variables. The sequence can then be exported from the design tools in a format that includes a traditional written sequence, diagrams, points list, and also a machine-readable version of the sequence that can readily be used by the control contractor.

There are many potential benefits to the co-design process including reduced system costs through optimized system selection and reduced installation effort, as well as optimized efficiency and performance of the system during the design phase. However, it also may increase the time, cost and complexity of developing the system design. The use of the new tools and processes has the potential to lower these costs over time. Ideally the additional value provided with the use of this process could be used to compensate the design team, while reducing overall projects costs for the owner.

## Spawn of Energy Plus

The final piece being funded by the US Department of Energy is the next generation of their energy modeling tool, "Energy Plus"[2]. The new version of Energy Plus has a number of enhancements including updated programming tools. It also will include the ability to more accurately model and simulate control sequences using a control modeling open standard called Modelica. Energy Plus is widely used in the research community and also provides the "back end" for calculating loads in several widely used commercial energy modeling programs.

## Vision

The three programs described above are intended to have a high degree of synergy. Used together, they have the potential to dramatically change the process for design and delivery of control systems, helping to overcome many of the current challenges that we face. The process would start with the concept of co-design – which means starting early in the process with models and other tools for the design of control systems. The modeling process could use Energy Plus, or any other energy modeling program that supports controls. System designers would either develop their own control sequences using CDL, or select from libraries of pre-written sequences, and then optimize the control parameters to meet the specific needs of the building. During the design process, the operation of the systems would be simulated allowing for potential issues to be resolved at this stage rather than during installation or checkout. The process flow then continues through installation and checkout, helping to eliminate much of the confusion and rework that exists in our current process. Note that when the project is completed, the owner takes over not only the building and associated systems, but also gets a copy of the model and the simulation tools. This model is what is often called a "Digital Twin" and can be used as a tool for continued decision making to optimize the performance of the building. The use of semantic tagging, such as Haystack is critical for the successful deployment of the digital twin, as well as for other tools for analysis, fault detection, and optimization.

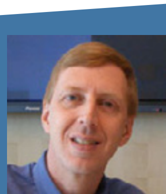
## Next Steps

While the concept of moving to a co-design process that is highly focused on detailed control design, modeling, and simulation has great potential benefits, it also has some significant challenges. Design teams often use some limited form of energy modeling on many projects, primarily to size and select equipment, but it is unusual to develop a detailed energy model. Developing a more detailed model that accurately simulates the envelope, systems and controls is a more complicated and often time (and skill) intensive task. Being able to develop detailed control sequences that are expressed in CDL also requires some additional training and expertise. The research efforts related to these new concepts will develop tools that would simplify and automate many of these new tasks. But it may also require some added skills, and changes to fees paid to system designers.

Perhaps this opens the door for firms to decide how they want to proceed. Some firms may elect to continue to be "full service" and focus on providing system design, modeling, simulation, controls, commissioning and even construction services. Others may elect to focus on one area or another. For example, you might see firms that are just focused on HVAC design, with others are focused on modeling and controls. Some of this work may even get spread out into the contracting community with the potential to have a firm that specializes in the design, installation and operation of controls, moving toward a design build model.


Veronica Adetola is a Control Systems Scientist and Team Lead in the optimization and control group at PNNL. She has more than ten years of experience in developing physics-based and data-driven advanced control solutions for energy-efficient systems and grid-interactive buildings.





Paul Ehrlich, P.E., is the Founder and President of Building Intelligence Group LLC. His work is focused on building controls, integration, and improving efficiency of commercial buildings.


**References:**


1. US Department of Energy Co-Design Project: www.energy.gov/eere/buildings/co-design-hvac-controls-and-sensing-energy-flexible-buildings
2. Department of Energy Spawn of Energy Plus: www.energy.gov/eere/buildings/downloads/spawn-energyplus-spawn
3. Department of Energy Open Building Control: obc.lbl.gov
4. ASHRAE Guidelines 13 and 36: www.ashrae.org

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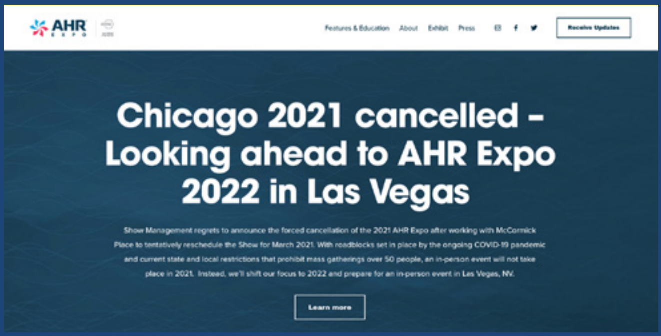
# Past & Upcoming Events




Chicago 2021 is Cancelled. Looking ahead to the 2022 AHR Expo in Las Vegas.

After exhausting all possibilities to tentatively reschedule the Show for March 2021, AHR Expo regrets to announce the forced cancellation of the 2021 AHR Expo in Chicago. With roadblocks set in place by the ongoing COVID-19 pandemic and resulting current state and local restrictions that prohibit mass gatherings over 50 people, an in-person event will not take place in 2021. Instead, they are shifting their focus to 2022 and are preparing for an in-person event in Las Vegas, Nevada.

Project Haystack is looking forward to participating in AHR Expo in 2022.

For questions regarding the cancellation of the 2021 AHR Expo in Chicago, visit: https://www.ahrexpo.com/updates/#update-faq.

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Project Haystack is proud to be a Supporter of the 2021 Building Commissioning & Energy Management Conference & Expo, a premier event in building commissioning, TAB and energy management.

The conference is presented by the Energy Management Association (EMA), AABC Commissioning Group (ACG) and the Associated Air Balance Council (AABC). CxEnergy 2021 offers pre-conference training & seminars, AIA-approved technical presentations with nationally recognized speakers, and the Expo Hall featuring the latest technology in the industry. Relationship-building opportunities allow your organization to interact with hundreds of attendees to get recognition in the industry and establish contacts with your peers. Project Haystack members receive a 10% discount with promo code HAYSTACK10. Register at: https://www.cxenergy.com.


## SAVE THE DATE
## 2021 Haystack Connect

Haystack Connect will be a

Virtual Conference in 2021.

The dates will be May 4 - 6, 2021.

Stay tuned for more information.

WG Working Group Updates

**Tagging initiatives are made official by launching a Working Group with a defined proposal and good visibility. Join a WG now!**

#792

# Haystack JSON Encoding Working Group

Champion:
Gareth David Johnson,
J2 Innovations

Haystack's new JSON encoding scheme (a.k.a Hayson) is progressing fast into being a real part of the Haystack standard. After an initial webcast with the working group, a specification and proposal document has been published online (see below).

Many contributors have already started using Hayson in their own products already!

The design goals of Hayson are...

A simple protocol that doesn't require extra parsing/work to work with data. In some cases, no client library is required. In short, this is making Haystack data more accessible for the masses.

It should look and feel as much as possible like standard JSON.

High fidelity: there should be no loss of data in the encoding.

Granular Haystack types should be granular JSON types. For example, a Haystack string is a JSON string. A Haystack boolean is a JSON boolean etc.

So what does Hayson look like? Here's a simple dict...

```
{
    “site”: “A site”,
    “num”: 123,
    “bool”: true
}
```

And here's a simple grid...

```
{
    "_kind": "grid",
    "meta": { "ver":"3.0", "foo": "bar" },
    "cols": [
      {
          "name: "id",
          "meta": { "size": 123 }
      },
      {
        "name": "dis"
      }
    ],
    "rows": [
        { "id": 1, "dis": "Hall" },
        { "id": 2, "dis": "Bedroom" }
    ]
}
```

Note how dicts are just simple JSON objects.

For more information on this new standard please checkout the specification and proposal document:

**https://bitbucket.org/finproducts/hayson/src/master/**

Check out the Working Group here:

**https://project-haystack.org/forum/topic/792**

# #667

# Cybersecurity Working Group

Champion:
Fred Gordy,
Intelligent
Buildings

From an Operational Technology (OT) cybersecurity perspective, 2020 has been a year of growth and change. In late 2019, NIST (National Institute of Standards and Technology) released NSITIR 8228, Considerations for Managing Internet of Things (IoT) Cybersecurity and Privacy Risks. This publication validated what we have all been saying for years. Building control systems cybersecurity risks cannot be addressed solely with IT methods. NIST makes the following three considerations and statements that clearly identify why.

- Consideration 1: Device Interactions with the Physical World
  - Many OT devices interact with the physical world in ways conventional IT devices usually do not.
- Consideration 2: Device Access, Management, and Monitoring Features
  - Many OT devices cannot be accessed, managed, or monitored in the same ways conventional IT devices can.
- Consideration 3: Cybersecurity and Privacy Capability Availability, Efficiency, and Effectiveness
  - Many OT devices cannot be accessed, managed, or monitored in the same ways conventional IT devices can.

(Reference - **https://nvlpubs.nist.gov/nistpubs/ir/2019/NIST.IR.8228.pdf**)

In addition to NISTIR 8228, NSA (National Security Agency) and CISA (Cybersecurity & Infrastructure Security Agency) jointly released a dual advisory that recognizes OT differences and outlines some basic best practices that are OT centric.

(Reference - **https://media.defense.gov/2020/Jul/23/2002462846/-1/-1/1/OT_ADVISORY-DUAL-OFFICIAL-20200722.PDF**)

2020 has also seen an increase is activity from the end user requesting site assessments. This and acknowledgment from NIST, NSA, and CISA of the OT differences has spawned several groups that are attempting to create a cybersecurity framework that is specific for building control cybersecurity. The Cybersecurity Working Group has been paused in part due to the disruption we have all had this year, but also to follow the efforts being put forth by groups such as BuildingCyberSecurity.org and (CS)2AI.org and not duplicate efforts. We will continue to follow the development of building cybersecurity frameworks and at some point, in the future begin to bring the best in class to Project Haystack.

I look forward to reconvening and putting together a program that is rooted in foundationally sound building cybersecurity framework.

Check out the Working Group here:

**https://project-haystack.org/forum/topic/667**

# Project Haystack Working Groups List

| WG | Topic | Champion |
|---|---|---|
| **#514** | Dry Bulb Points and The 'air' Tag | Jay Herron |
| **#551** | Haystack Type System WG | Brian Frank |
| **#626** | RESET Standard and Air Quality Tags | Cory Mosiman |
| **#496** | Lab/Fume Hood Working Group | Gabe Sandoval |
| **#501** | Flow Modeling working group | Karine Lavigne |
| **#503** | Access Security Working Group | Justin Tashker |
| **#505** | Refrigeration System | Nathan Rona |
| **#506** | Unitary Equipment Working Group | Eric Loew |
| **#553** | Reference Model | Patrick Coffey |
| **#492** | New Data Center Tag Working Group | Ron Snyder |
| **#530** | BIM/Haystack Working Group | Chris Renter |
| **#667** | Cybersecurity Working Group | F Gordy |
| **#701** | Data Center Tags | Jason Ganiatsas |
| **#709** | Haystack RDF Export - Working Group | Matthew Giannini |
| **#776** | Working Group: Greenhouse Gas | Matthew Giannini |
| **#734** | Working Group: ATES Systems | Jaap Balvers |
| **#497** | Chiller Plant Enhancements Working Group | Sean Stackhouse |
| **#595** | Invitation to Project-Sandstar Working Group | Alper Üzmezler |
| **#705** | Lighting Systems WG | Jeremy Yon |
| **#792** | Haystack JSON Encoding WG | Gareth David Johnson |
| **#609** | AHU Standing WG | Jay Herron |
| **#837** | Haystack Labs Standing WG | Cory Mosiman |

**To learn more or to join a Working Group, visit:** https://project-haystack.org/forum/wg

## Tools for Developers & Integrators

**The Project Haystack community develops and freely offers a range of reference implementations to enable product manufacturers and application developers to quickly implement Haystack tagging and communications in their products.**

**Wiki**

Haystack Wiki: Source for docs, and tag definitions

**Java**

Haystack Java Toolkit: Light weight J2ME compliant client and server implementation

**Niagara**

nHaystack: New Updated Niagara module to add Haystack tagging and Niagara REST API for AX and N4

**C++**

Haystack CPP: C++ Haystack client and server implementation

**DART**

Haystack DART: Client library for Dart programming language

**Node**

Node Haystack: node.js client/server implementation

**Python**

pyHaystack: Python client implementation

## Check out these documents and audio resources to quickly come up to speed on Project Haystack tagging benefits and the methodology.

**Download** Detailed Reference Implementation Document. "Implementing Project Haystack: Applying Haystack Tagging for a Sample Building."

**Download** Harbor Research whitepaper with technical overview. Defines the concept of tags, breaking down and explaining the essential data elements.

**Listen** Audio Stream of "Making Internet of Things Device Data Just Work!" a Memoori webinar featuring John Petze and Marc Petock on Project Haystack.

**Open** REST API Description. Explains simple mechanism to exchange tagged data over web services

**Download** Haystack Guide Specification. Now available in English, French and Chinese.

**Download** CABA whitepaper that outlines how to use Haystack tagging in applications related to buildings, energy, and facility management.

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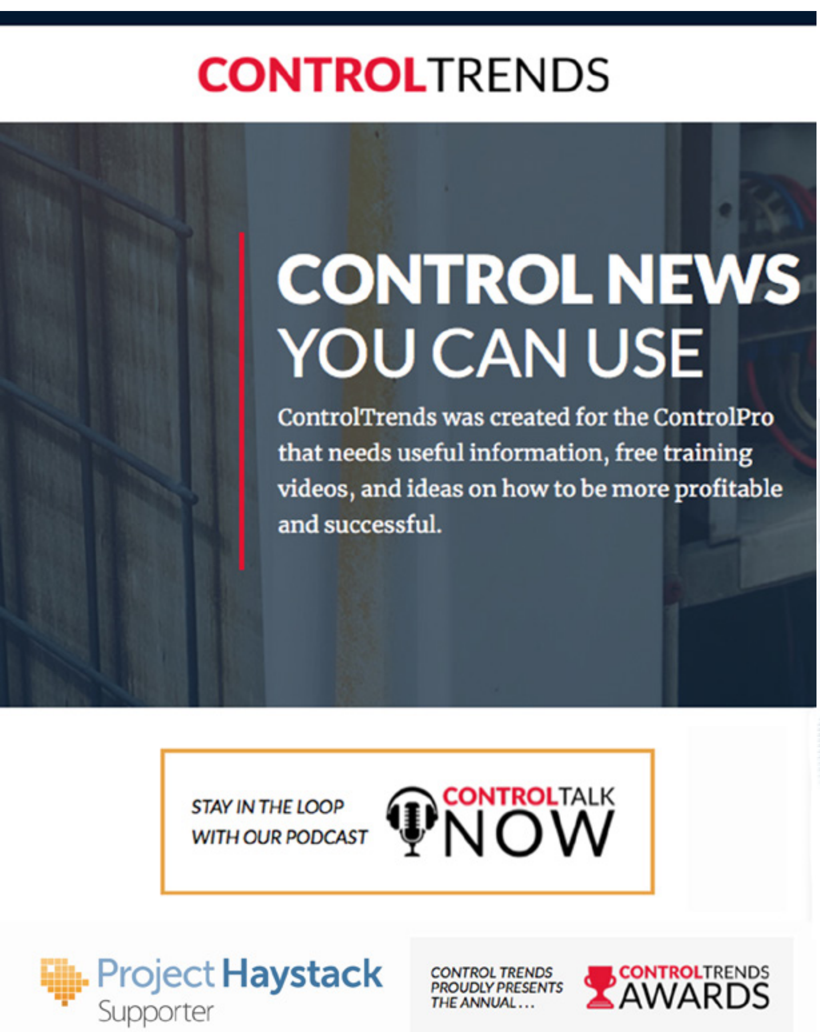
## Want to get involved in the Project Haystack open-source community? There are a number of ways and levels of involvement.

**Contribute your expertise:** Participate in the Project Haystack open forum discussions.

**Join a Working Group:** Project Haystack has members working together on developing tag sets and resolving other challenges related to particular topics. See the list of active Working Groups that you could join today here.

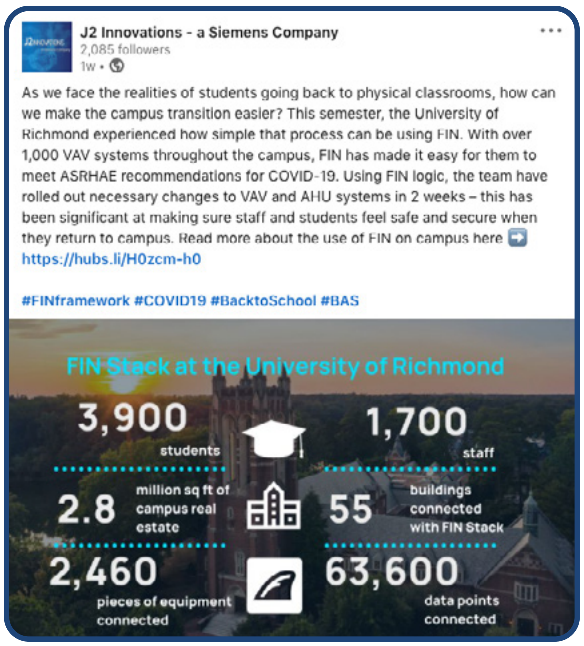
**Become a Member:** Project Haystack Corporate Associate Memberhip has many advantages. Email us to learn more at projecthaystackinfo@gmail.com.

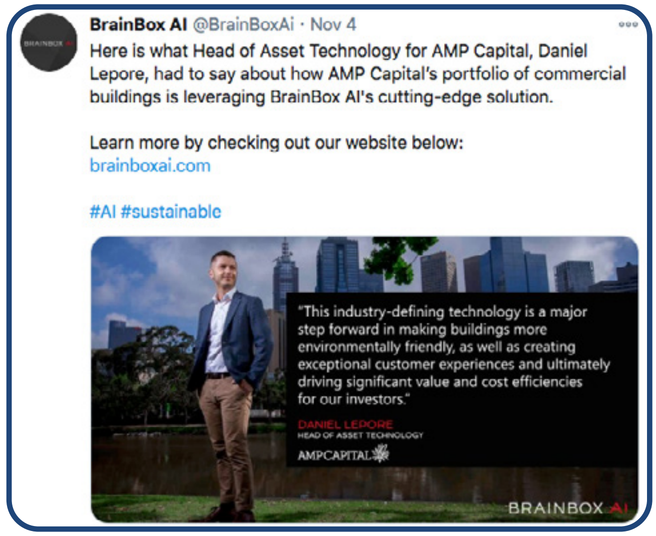
## Social Media Curation

Here is some of the information shared by Project Haystack members on Instagram, Twitter and LinkedIn. Follow them to learn about Haystack-enabled recent projects, products and practices.

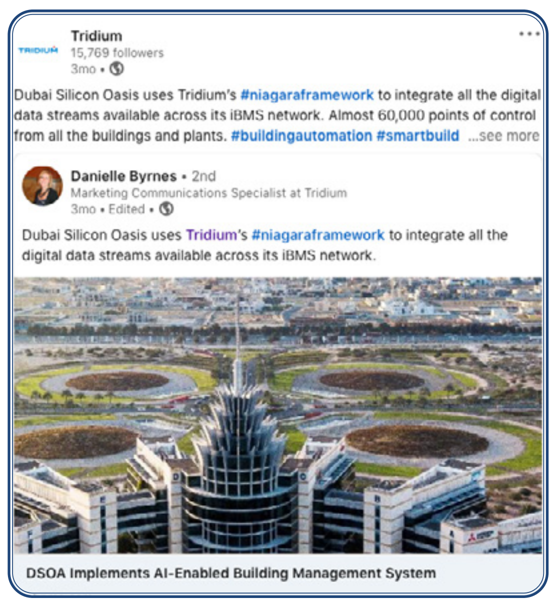
# Projects




*With over 1,000 VAV systems, FIN makes it easy to meet ASHRAE recommendations for COVID-19.*

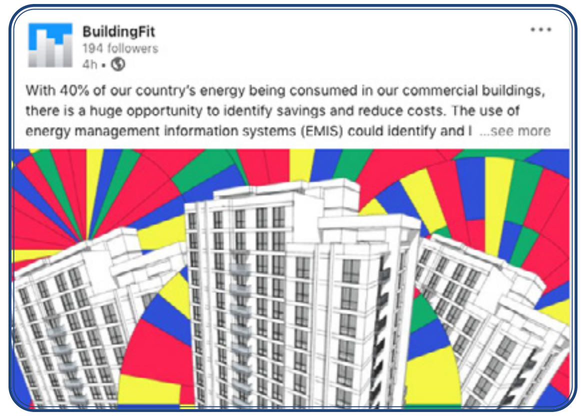



*AMP Capital to Roll Out Energy Saving AI Technology Deployed by BrainBox AI.*

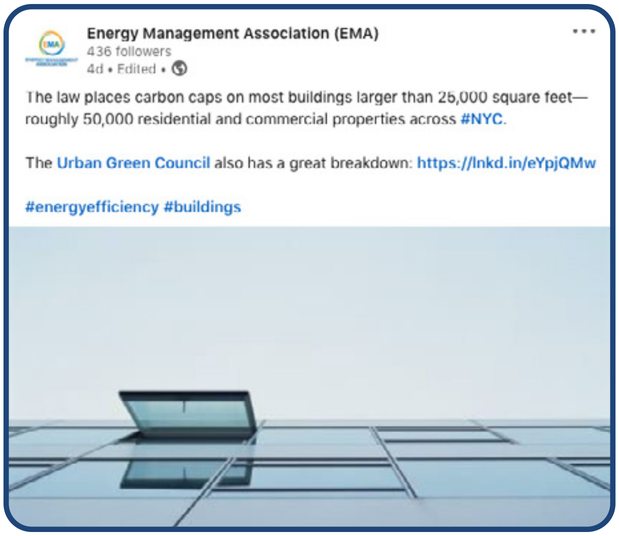



*Dubai Silicon Oasis using Tridium Niagara Framework to integrate all data streams available across its iBMS network.*

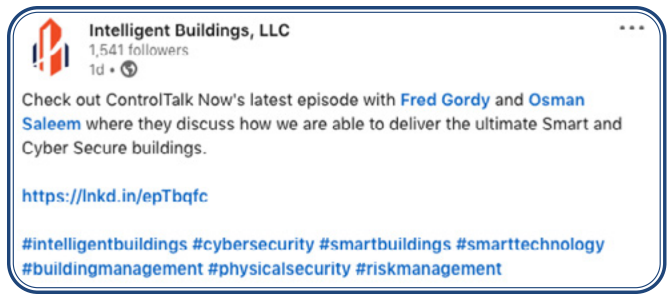
# Practices




How We Could Save $4 Billion in Building Energy Costs - Without Any Renovations.




NYC's Local Law 97 places carbon caps on most buildings larger than 25,000 square feet—roughly 50,000 properties.




How to Deliver the Ultimate Smart and Cyber Secure Building.

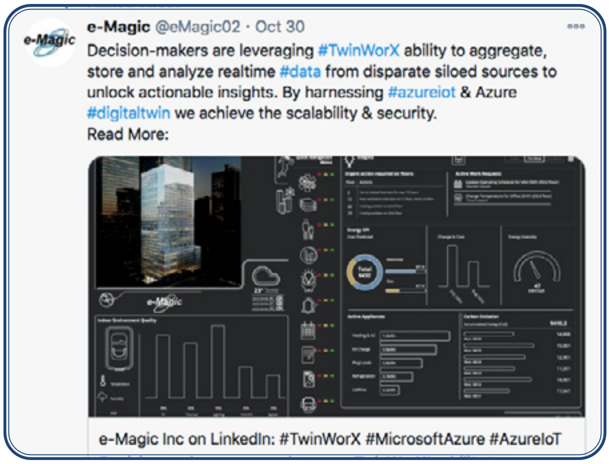


COVID-19 Lockdown Leaves Empty Smart Buildings to Ponder their Failings.

HVAC/R Performance Monitoring for New Public Health Regulations.

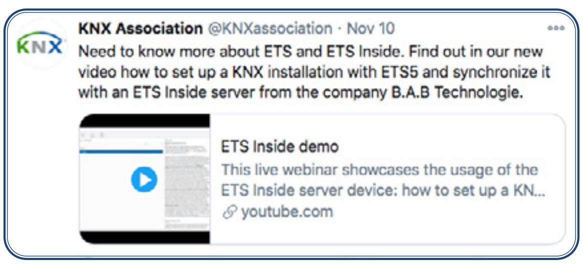
# Products


*New SkyFoundry SkySpark App for Managing Data Analytics.*

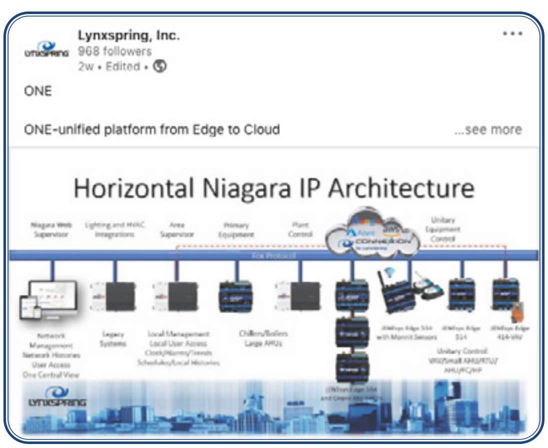



*Leverage TwinWorX to Unlock Actionable Insights.*


*KMC Controls Adds Tosibox Products to their Catalog.*




*How to Set Up a KNX Installation with ETS5.*




*Lynxspring's ONE-Unified Platform from Edge to Cloud.*


*Designs for Distance.*


*CABA White Paper on Wireless Power Transfer.*


*New Version of J2 Innovations KNX IP Connector.*


*Accu-Temp Systems Partners with Stratis.*


*PlantPRO Can Provide Up To 40% Savings in Energy Consumption.*

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Project Haystack connections

## Become an Advertiser

The Project Haystack Connections Magazine advertising program is a cost-effective way for companies that provide complementary products and services to reach the growing and dynamic Project Haystack Community. This community is at the very forefront of intelligent buildings and the IoT. Haystack Connections is a premier advertising vehicle to reach this prime audience. With 8,000+ known readers, it is an incredibly cost-effective advertising opportunity. For rate info, email: **robin@haystackconnect.org**.

# Members

## Founding Members

Conserve It was founded in 2007 with a focus on centrifugal chiller efficiency systems. Over time it has diversified into complete HVAC&R plant management including monitoring, reporting and controls, energy performance contracting, energy management consulting and distribution of industrial and building automtion products and sensors from leading international suppliers worldwide. Conserve It provides a range of unique products and services in this area.

J2 Innovations brings powerful engineering tools, visualization and software technology to those involved in BAS installations. J2 is the developer of FIN Stack, a software technology that combines the core functionality of a Building Automation System (BAS) for connecting and controlling devices with the added benefits of a Building Operating System (BOS) to manage and leverage data. The technology uses Project Haystack tagging and data modeling to provide unprecedented capabilities and functionally.

As a leader in electrical and digital infrastructure solutions for all types of buildings, Legrand helps enhance everyday life for its customers. Legrand's Eliot program (Electricity and IoT) is speeding the deployment of Legrand's connected devices and accelerating the evolution of connected buildings. Eliot is powering development of new Legrand products for the benefit of private and professional users alike.

Embracing open software and hardware platforms, Lynxspring develops and manufactures innovative edge-to-enterprise solutions. We enable better building automation, better energy management systems, better control systems and specialty machine-to-machine and IoT applications. Deployed in billions of square feet of commercial buildings across North America and beyond, Lynxspring's smart solutions simplify integration and interoperability, and help connect your smart building's data.

Siemens Building Technologies consists of three Business Units: Building Automation (BAU): Control Products and Systems (CPS); Fire Safety and Security (FSS). These business units combine offerings for building security, life safety and building automation within one company as a service and system provider, and as a manufacturer of respective products. By virtue of the unique combination of these business sectors, the company occupies a leading position worldwide.

SkyFoundry's mission is to provide software solutions for the age of the "Internet of Things". Areas of focus include building automation and facility management, energy management, utility data analytics, remote device and equipment monitoring, and asset management. SkyFoundry products help customers derive value from their investments in smart systems.

# Associate Members

Accu-Temp Systems is committed to delivering safe, comfortable environments for its customers. It leverages tools like secure mobile devices, cloud computing and advanced analytics. It offers systems integration services that help building owners protect their investment in existing direct digital controls, extending their useful lifetime while enjoying next-generation access and control.

Altura Associates is a professional services firm that goes beyond the traditional consulting model.  Our team works closely with our client organizations to develop programs that offer immediate and lasting impacts, build capacity, and drive long-term value. The team combines expertise in mechanical/electrical engineering, energy management, environmental science, and financial analysis.

BASSG is an innovator in building automation technology and BAS analytics delivery. Its BASSG branded in-house developed easy-to-deploy, multi-system software tools reduce BAS implementation and facility management energy costs. BASSG also has multiple distributorships and can be a one-stop provider for everything-BAS at unbeatable value.

BrainBox AI is at the forefront of the green building revolution with its unique technology combining artificial intelligence and cloud computing to create a fully autonomous commercial HVAC solution. BrainBox AI overlays deep learning algorithms on existing HVAC functionality to automate the modulation of each component, reducing a building's total energy spend by up to 25% while improving occupant comfort by 60%. The solution leverages AI to predict building energy consumption at a very granular level and enables our autonomous HVAC system to operate the building pre-emptively.

BUENO Systems is the Australian leader in data and information driven operational property services. BUENO delivers superior data related and technology driven services based on fault detection, optimization and business intelligence that simplify their clients operations and enhance their effectiveness across all building sectors and building information systems.

BuildingFit creates unique solutions for clients to ensure a proper fit between SkySpark® and their team. We do this through site construction, analytics, custom programming, SkySpark® Apps, reports, training, SkySpark® Licensing. BuildingFit is a SkyFoundry endorsed SkySpark Essentials provider.

The Continental Automated Buildings Association is an international not-for-profit industry association dedicated to the advancement of integrated technologies for homes and buildings. The organization supported by an international membership of over 300 organizations involved in the design, manufacture, installation and retailing of products relating to home and building automation.

# Associate Members

e-Magic Inc. specializes in providing expertise and software for the design, development, and integration of large scale industrial IoT and Azure Digital Twins solutions globally Applications include Centralized Operations, Smart Buildings, Facilities and Cities, Smart Manufacturing, Industrial production and AI for prediction and optimization. Our solutions have been installed in a wide range of industrial sectors including: buildings, facilities, manufacturing, utilities, mining and metals, cement, oil and gas, food and beverage, chemical, petrochemical and pulp and paper.

EMA is a trade association dedicated to providing education, training, and certification in the field of building and facility energy efficiency. Its Energy Management Professional certification (EMP) has achieved accreditation by ANSI and is recognized by the Department of Energy's Better Buildings Workforce® program.

Intellastar Technology is at the Intersection of Smart Buildings and Smart Grid. The InferStack Software Platform is deployed in Servers and T-Star Field Devices, communicates over Intellastar Connect Cellular Data Service, to provide a complete technology to deliver Smart Buildings and Smart Grid solutions.InferStack connects to the in-building systems to provide Energy Monitoring and Analysis, Analytics for Fault Detection and Diagnostic, Control for Plant Optimization--all features to make a smart building and reduce energy consumption and waste.

Intelligent Buildings, LLC, a nationally recognized smart real estate advisory services company, provides planning and implementation of next generation strategy for new buildings, existing portfolios and smart communities. Their work includes "The Smartest Building in America", the largest energy analytics project in North America, the smart buildings standards for the U.S. and Canadian governments, conception and management of a Clinton Global Initiative and the recently released Intelligent Buildings CyberSafe service.

IoT Warez develops custom software that helps technologies communicate together. From state of the art data centers to environmentally conscious facilities, our software development team is capable of building solutions that connect anything and everything. IoT Warez offers a suite of hosted software options that provide customized solutions. Our platform-as-a-service connects multiple brands of software into one platform that can be remotely managed from a smart device.

KMC Control is an American manufacturer of open, secure, and scalable building automation solutions. From secure hardware devices to smart and connected software, KMC delivers embedded intelligence and optimized control.. It is committed to providing industry-leading Internet of Things-enabled automation solutions with leading tech suppliers to increase comfort, convenience and to help reduce energy usage.

KNX Association represents KNX technology now used in applications for lighting and blind control, security systems, HVAC, monitoring, alarming, water control, energy management, smart metering as well as household appliances, audio/video and more. KNX provides a single, manufacturer-independent design and commissioning tool (ETS), with a complete set of supported communication media and configuration modes. It is approved as a European and an International standard.

# Associate Members

Kodaro expands building system connectivity through dynamic software developed for the Internet of Things. It helps contractors, controls companies and end-users find value in building data gathered from the edge to the cloud. It develops software to create more connectivity between systems, giving increased access to better data, not bigger data. Kodaro's goal is to provide actionable analytic information, developed from real-world expertise with all building systems.

KODE Labs has developed an enterprise level platform which streamlines the routine tasks of discovery, templating, tagging and data configuration and provides complete monitoring and control of building systems. The KODE Labs platform offers a data focused interface that surfaces the critical insights necessary to maximize operational efficiency across your portfolio.

Resolute provides a building-performance analytics and reporting solution that integrates with the Niagara Framework®, enabling quick and reliable use of real-time data, analytics-driven insight and on-demand reports to better manage buildings and achieve quantifiable performance gains. Leveraging the power of Project Haystack standardized data and tagging models and the Niagara open-source connectivity protocol, our solution allows direct connectivity to the Resolute Cloud™ from a Niagara instance - regardless of brand - without the need for additional devices.

Tridium is a world leader in business application frameworks - advancing truly open environments that harness the power of the Internet of Things. Our innovations have fundamentally changed the way people connect and control devices and systems. Our products allow people and machines to communicate and collaborate like never before. They empower manufacturers to develop intelligent equipment systems and smart devices for enterprise and edge assets.

Through the implementation of WideSky®, we aim to unlock the value of your energy, environmental and building data. Our scalable, intelligent solutions can improve profits and sustainability of your business. The qualified and experienced WideSky team has decades of operational and information technology experience. Coupled with our partner network, we can implement future-proofed, well-supported solutions tailored to your business on a global scale.

Yorkland Controls has roots in distributing and warehousing heating control products such as Flame Safeguard and Burner and Boiler Management Systems, and has expanded into new markets including Building Automation, Lighting, Security and Energy Services. It works to promote the advantages of controls to the industries and markets that it serves and to demystify available technology for its customers.

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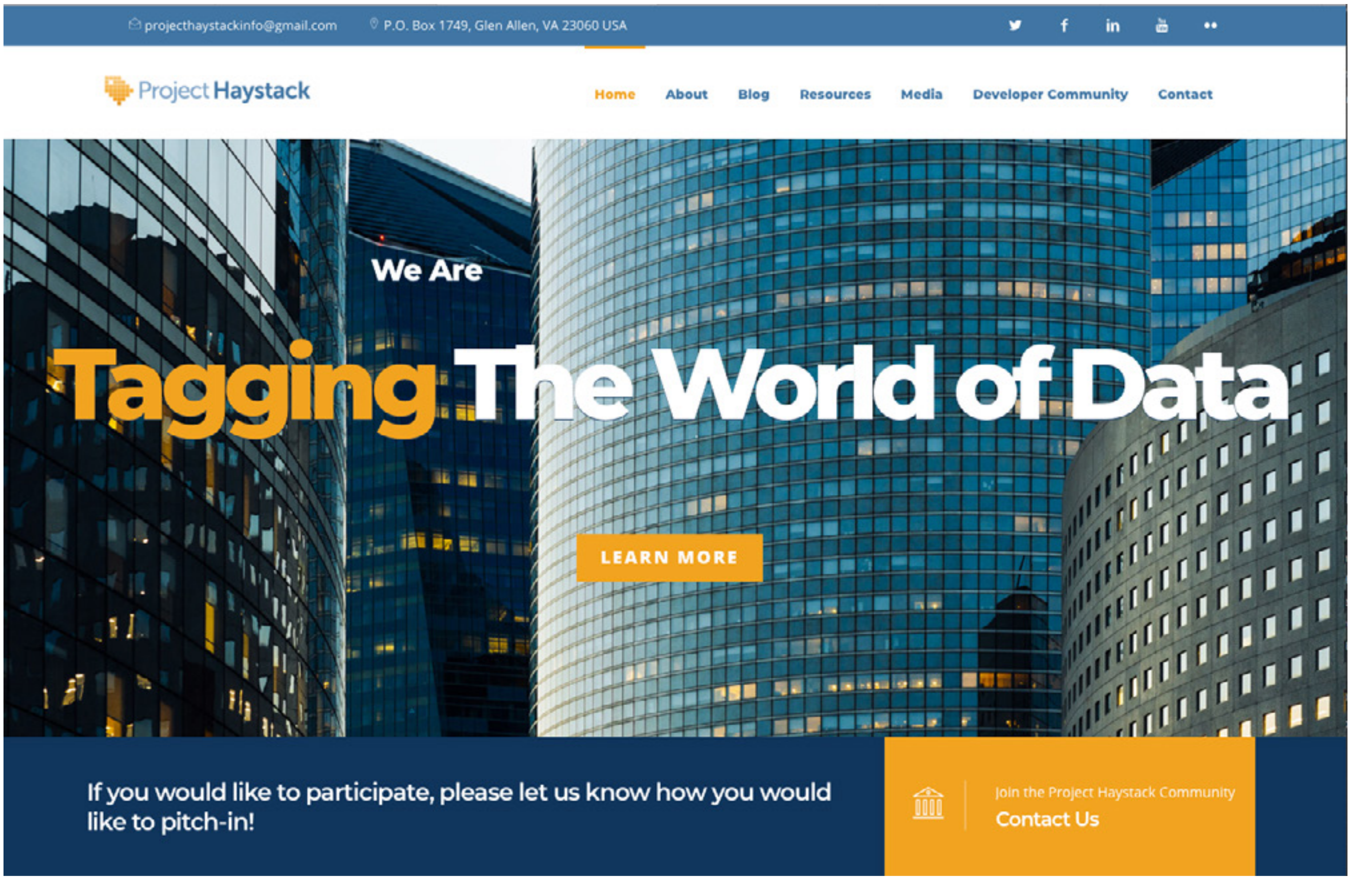


Project Haystack

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