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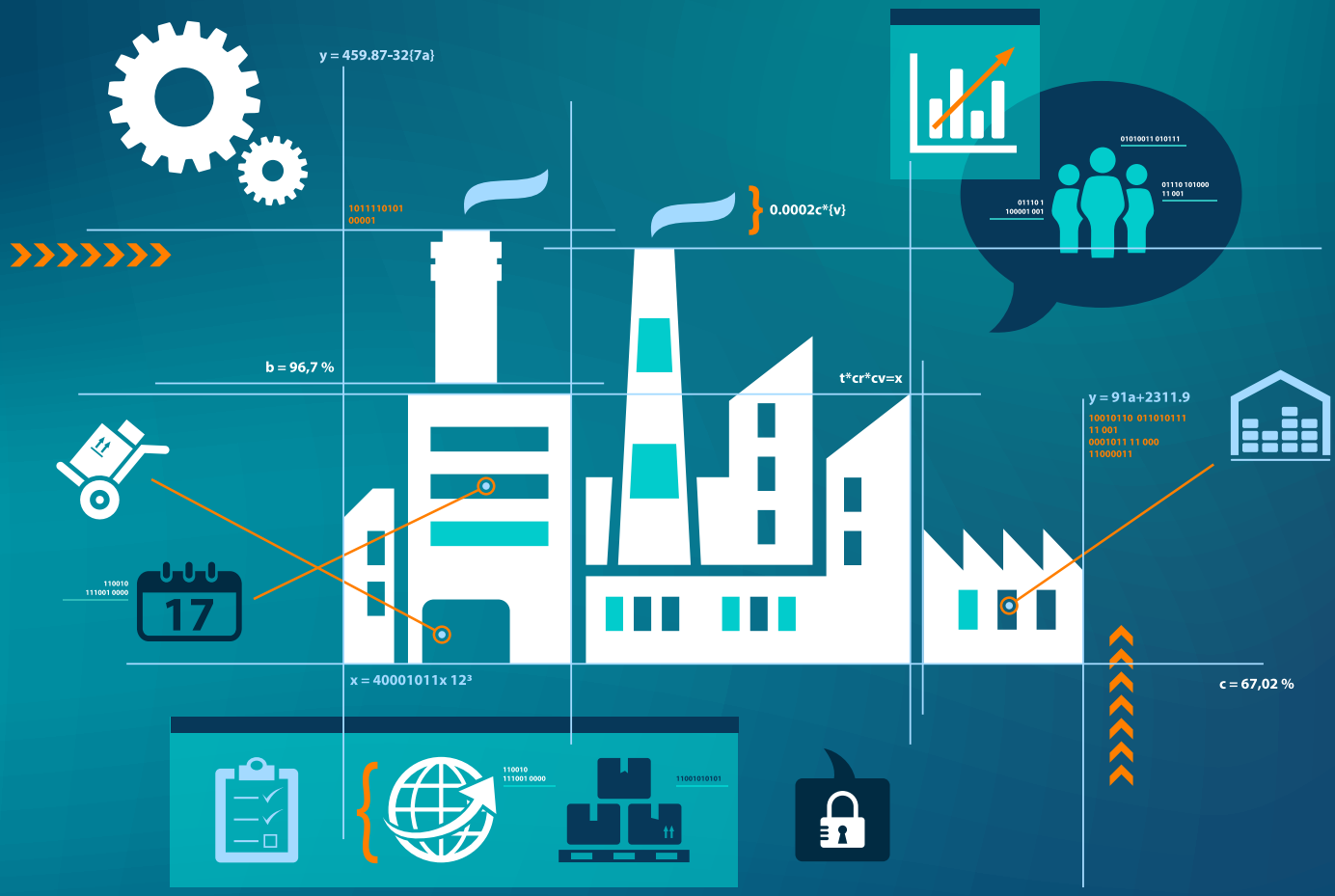
Project Haystack

ISSUE 10

connections

Journal of the Haystack Community - Solutions for Interoperable Device Data

Data. Our New Asset.



- Haystack 4 Update
- New Haystack Essentials Training
- Tagged Data Analysis Using Maching Learning
- Need for Scalable System Interoperability
- The Role of Semantic Tagging
- Automated Functional Testing Has Arrived and Yes It Works

www.project-haystack.org

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Simplify Equipment Control & Optimization for Equipment Manufacturers with FIN ECO

40% energy saving**

30% maintenance saving

In commercial buildings, HVAC accounts for 45% of total energy consumption with 65% of this used in the plant room*

By integrating chillers, pumps, air handling units, cooling towers and other related equipment with FIN ECO, OEMs can save up to 40% of energy and up to 30% on maintenance costs in the plant room.

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- Plant performance monitoring
- Smart sequencing, optimization and control
- Diagnostics, maintenance and reporting
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- Secure remote connection to equipment
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j2inn.com/fin-eco

J2 INNOVATIONS
A Siemens Company

*Source: US Department of Energy (DOE) **compared to manually controlled HVAC plants

CONTENTS

EDITORIAL

PROJECT HAYSTACK

CONTRIBUTED ARTICLES

HAYSTACK CONNECT 2021 RECAP

CONTENTS *cont'd*

NEW MEMBER PROFILES

EVENTS

WORKING GROUP UPDATES

TOOLS FOR DEVELOPERS & INTEGRATORS

SOCIAL MEDIA CURATION

DIRECTORIES

10 Years and Our 10th Issue of Connections

by Robin Bestel, Managing Editor, Project Haystack Connections Magazine

Welcome to the 10th issue of the Project Haystack Connections Magazine. This tenth issue, published coincidentally during the organizations 10th Anniversary celebration, demonstrates the importance of the work being done by the whole, world-wide Project Haystack Community.

After a year of everyone locked down in their virtual offices, it was followed by this past year of figuring out how we can all move forward and what matters most when it comes to our livelihood, safety and well-being.

For anyone in this industry, the work of the Project Haystack community this past year became more important to everyone. And, a year when Data became our biggest asset.

Hence, how we titled the theme of this issue of Connections Magazine. **Data. Our New Asset!**

The past year, and even just the past few months since our last issue of Connections Magazine, Project Haystack has finalizing Haystack 4.0 and launched the new **Project Haystack Developers** website, held our 5th biennial Haystack Connect Conference, albeit virtually, and Project Haystack was selected for funding under the DoE Building Technologies Office Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) Funding Opportunity.

This issue features the launch of Project Haystack's first eLearning course, "Haystack Essentials". In collaboration with accredited eLearning training provider, Fantom Factory, we now have online interactive training – on demand!

And, once again, Brian Frank gives us the latest update on Haystack 4.

Articles were submitted by new contributors including Energocentrum Plus, the DLR Group, PADI and CloudBlue, and the Epsten Group. Thank you again to Tridium, J2 Innovations, Lynxspring, and BuildingFit for their contributions, too.

This issue also includes updates to some of the Working Groups, information on upcoming events, and we have a section dedicated to Haystack Connect and links to all of the session speaker videos.

I hope you will join me in welcoming our two newest Associate Members to the Haystack organization. They are 75F and Switch Automation and are featured in the section "**New Member Profiles**".

Thank again to everyone that contributed to this 10th Issue of Connections Magazine. I aslo want to wish everyone a safe, healthy and a prosperous New Year in 2022!

Project Haystack

Founding Members

Conserve it

J2 INNOVATIONS
A Siemens Company

legrand®

LYNXSPRING®

SIEMENS
Ingenuity for life

SkyFoundry

Associate Members

75F

Accu Temp
Building System Integrators

ALLANDER ANALYTICS

ALTURA

Automated Logic

BAS SERVICES GRAPHICS

BRAINBOX AI

bueno
Built Environment Optimisation

buildingfit
Making SkySpark® Work For You.

buildingsIOT

CLOCKWORKS ANALYTICS

CABA
Continental Automated Buildings Association

e-Magic

EMA
ENERGY MANAGEMENT ASSOCIATION

Intellastar

INTELLIGENT BUILDINGS

KMC CONTROLS

KNX®

SWITCH AUTOMATION

TRIDIUM

WideSky

Yorkland Controls
ENVIRONMENTAL SOLUTIONS

Just How Far We Have Come – Leading the Effort for a Standard Metadata Solution for the Built Environment

Project Haystack is a globe-spanning, volunteer-driven, effort and it's easy to miss all the advances and milestones this unique organization continues to deliver to the industry. I myself often find it hard to keep up even though I am intimately involved. So, as we start a new year, I think it's worth commenting on some of those advances.

Corporate Membership Grows in Numbers and Reach

More and more organizations recognize the value provided by Haystack and have adopted it in their products and services and are demonstrating their support by joining as Associate Members of the organization. Notably, these organizations are often competitors in the market, yet come together to collaborate on the critical work of achieving data interoperability – work that will benefit both the individual companies and their customers. Just look at the current roster of Founding and Associate Members.

New Working Groups

One of the key advantages of Project Haystack is that we bring together domain experts that understand diverse and complex equipment systems, to work directly with data modeling experts to apply Haystack tagging to systems and devices of all types. This is the reality of the challenge - it takes both skill sets – people that intimately understand complex equipment systems and people that understand data modeling, software, and the tools provided by Haystack. This direct involvement by real world practitioners across the globe is one of the primary forces driving adoption of Project Haystack.

Some notable, recent examples include:

- Labs Working Group meets every two weeks to advance core concepts
- VRF (Variable Refrigeration Flow) Working Group
- Aquifer-based Thermal Energy System (ATES) Working Group
- Greenhouse Gas Working Group
- Air Quality Tags

DoE BENEFIT Project Funding Award

Project Haystack was selected for funding under the DoE Building Technologies Office Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) Funding Opportunity. Submitting for this award was a huge undertaking for a core group of community members. The award launches a project under which Project Haystack will create a validation framework for semantic metadata models to bring the industry an accreditation system for semantic interoperability. This will lower costs, reduce installation time, improve delivered quality, and remove knowledge barriers for service implementers. The project kicks off in the New Year (2022) with technical team participants from Clockworks Analytics, Switch Automation, SkyFoundry and NREL. The award is a huge vote of confidence for the Project Haystack effort and organization.

Haystack Connect 2021 Conference

2021 also saw the organization host the biennial Haystack Connect conference – this year converted to a full virtual, live event due to the pandemic. Speakers from around the world presented case studies, new tools and products, and updates from Working Groups. For proof of the value and adoption of Haystack worldwide look no further than the presentations from the conference. All the content from the event was recorded and is available for viewing starting on Page 46 or by visiting: https://www.haystackconnect.org/schedule.

Continued Outreach and Promotion of Industry Collaboration

Throughout the history of the Project Haystack organization, we have actively fostered openness and inclusion to bring together input from all facets of the industry.

Notably, in early 2018, we were successful in gaining support from ASHRAE BACnet and Brick to come together to try to align the work being done by each respective organization, with the goal of reaching a unified, consensus-based standard to address semantic interoperability of data from building systems. That collaboration was formally announced in March 2018 and proceeded with good engagement and results for about 18 months. The input and critique received through that process led directly to many of the advances that became part of Haystack 4. We continue in our effort to help lead the industry to achieve the goal of a unified approach for semantic interoperability of building system data.

And on that note, I will close with my sincere call to the industry – those active in the Project Haystack organization and those working to address the challenge under other organizations – to revitalize the effort to collaborate in order to achieve our important goals. Our customers deserve no less and history will not judge us kindly if we let this opportunity slip away.

John Petze
Executive Director
Project-Haystack.org, a 501c Corp
johnp@haystackconnect.org
http://project-haystack.org

Haystack 4 Update

Haystack4

Since the Spring 2021 issue of Connection Magazine, there have been several new preview releases of Haystack 4 and we have begun the official roll-out of Haystack 4!

Shortly before Haystack Connect in May this year, we updated www.project-haystack.org to the new Haystack 4 documentation. Although there are still a few T's to cross and I's to dot, Haystack 4 is now the official version for Project Haystack. The parallel site, www.project-haystack.dev that we ran during the Haystack 4 preview, is now shutdown (it redirects to the dot org site). We encourage everyone to start their transition to Haystack 4.

An extensive amount of new documentation has been written since last spring including sixteen new chapters of documentation. The new chapters include introductory concepts for how to model horizontal entities such as sites, spaces, zones, equipment, and points. And we have re-written many of the vertically oriented chapters related to AHUs, VAVs, central plants, and meters. At this point, the new Haystack 4 documentation is more, or less, complete.

The 3.9.10 preview release in April added several new features including:

- New JSON format dubbed "Hayson"
- Greenhouse gases
- New air quality tags
- Integration of the ATES WG proposal for aquifer thermal energy storage systems
- New download options for prototypes
- Improved specifications for state, VFDs, dual effective setpoints, flow meters, and meter loads

In September 2021, the 3.9.11 preview release included:

- Formalization of the HTTP API operations as first-class defs
- Additional greenhouse gas tags
- Open-source tools to build ontology and documentation from source

There are a couple of open proposals related to completing the Haystack 4 design, including:

- Simplifying how choices work for the common use cases
- Redesigning how choices work for the advanced use case
- Redesigning ref domain/referent to avoid def explosions
- Finalizing the inference filter operator
- Removing the equipFunction taxonomy

If you have comments or feedback on this release, please open a new forum post for each topic to organize the conversation.

https://project-haystack.org/forum/topic/908

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.

Haystack 4 Training

"Project Haystack is proud to announce the arrival of our very first training course. In collaboration with accredited eLearning training provider, Fantom Factory, we now have online interactive training – on demand!"

We, at Project Haystack, continue to publish a wealth of information about our Haystack Tagging standards in a number of ways. We have dedicated websites, online articles, forums, working groups, recorded video discussions, and of course, this fantastic magazine!

Further to all of this, and by popular request, we wanted to provide even more guidance on HOW to apply the Haystack Tags to real building environments.

We now address this with the new "Haystack Essentials" elearning course!

What Does It Teach?

"Haystack Essentials" is designed for anyone new to Project Haystack and to understand what Haystack Tags are and how to apply them to a basic site model.

Using interactive exercises in the digital screens, you'll practise applying these tags into example scenarios and models.

Draft Course Syllabus*

Module 1 - Introducing Haystack

Starting at the very beginning, you'll learn how Haystack tagging solves common data problems and enables data modeling.

Module 2 - Tags and Values

Looking at the syntax of different tag kinds in more detail and where to reference them in the open source libraries.

Module 3 - Navigating Haystack

Exploring more theory behind using tag relationships and definitions.

Module 4 - Applying Tags to Basic Equipment

Introducing the applied use of tags to basic level equipment to return successful data queries.

Module 5 - Referencing Tags Equipment

Using referencing techniques whilst applying tags to larger scale equipment models.

Module 6 - Tagging Site Models

Practising the application of tags to a site model, building on the previous training modules.

**As of the time of publication.*

When Is It Ready?

The full course is almost ready and should be available via the Fantom Factory eLearning platform early 2022.

How Much Will It Cost?

"Haystack Essentials" will be priced at $175 per seat, available for purchase online.

Training Benefits

Successfully complete the full course to receive a certificate of achievement and a personal training report.

Log in at any time and resume training. Really helpful for different schedules and time zones!

Feel supported with optimised multimedia content for individual learning styles.

Retain knowledge easier with interactive questions and scenarios, designed to consolidate identified key learning points.

Training Help and Resources

Trainees can always reach out to Fantom Factory for speedy help on a section of training.

A wealth of resources are provided on the Project Haystack websites, www.project-haystack.org and marketing.project-haystack.org, including the ability to contact peers directly through the forums.

Free Training

We are very proud of our new training and can't wait to share it with you all. Therefore, we have decided to release **Module 1 - Introducing Haystack** as a standalone training experience and is completely FREE!

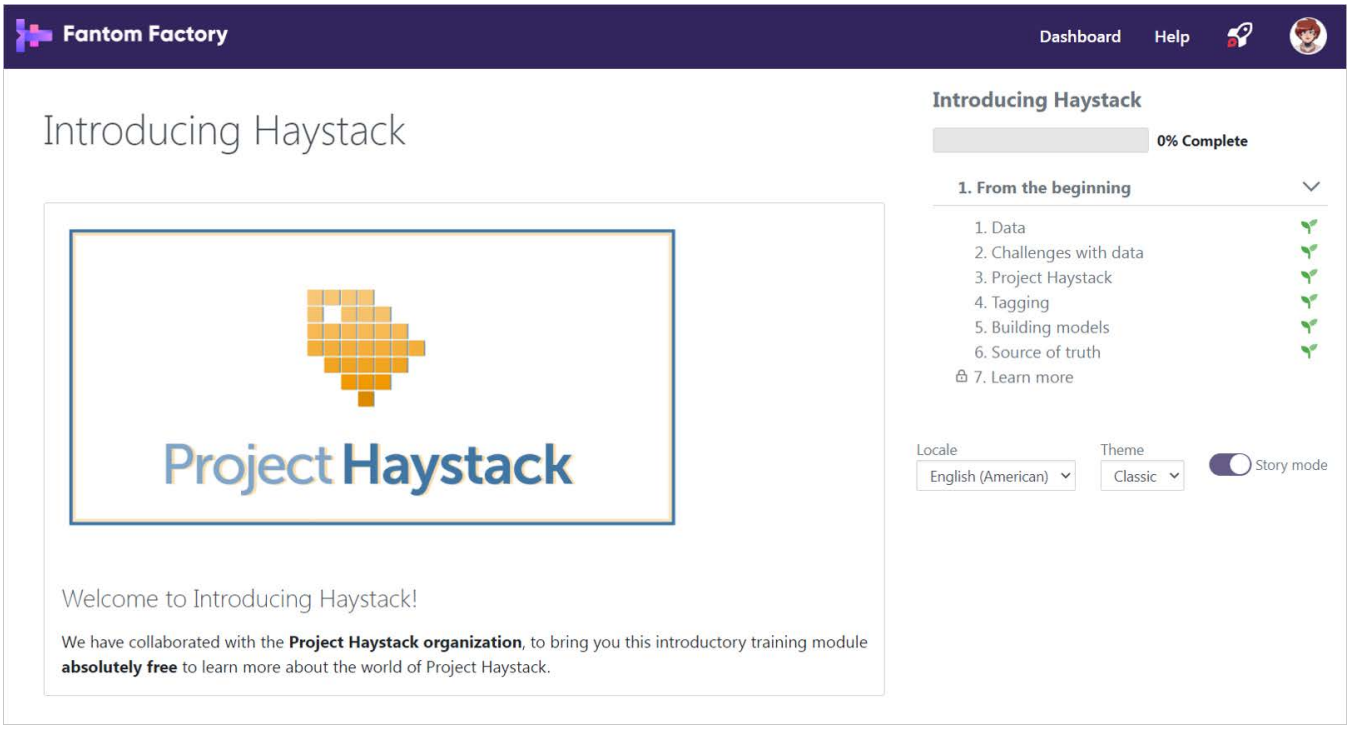
So if you are new to the world of Project Haystack, enjoy our complimentary interactive training experience and learn what it's all about!!

"Introducing Haystack"

This **FREE** introductory training is available now and covers the following:

- An overview of using Data in the Smart Building environment
- A look at the typical problems experienced with using data
- How Project Haystack solves these challenges
- An overview of how Project Haystack tagging works
- The use case for tags to create building models
- Discover the various Project Haystack online resources
- Find out the next steps to continue your training!

Gain instant access to the "Introducing Haystack" eLearning course by visiting the Fantom Factory website: https://www.fantomfactory.com/discover-our-range-of-elearning-courses.



Emma Eynon co-founded Fantom Factory to help make technology accessible to those who aspire to save our planet. She is passionate about training and communication, and has a wealth of experience in technical writing and content management systems.

70's-Era Big-City Plaza Transforms from Inside Out With N4 Upgrade

TRIDIUM

"Integrating so much existing equipment inevitably leads to the discovery of mechanical issues present in such a large system. Half the battle of improving existing systems is in finding and replacing the equipment that has likely not worked properly for a long time."

Owners and operators of large metropolitan buildings have many reasons to keep their building automation and controls infrastructure up to date. When you are managing a portfolio with assets that are typically 50 to 100 years old, deploying the latest tech is one thing you can do to modernize. Buildings in the Midwest USA, for example, are estimated to be responsible for nearly two-thirds of a city's greenhouse gas emissions, and building owners there have been aggressive in their use of technology to cut carbon use, ease demands on the local power grid and save money.

Now, in the 2020s, Big-metro property owners are pioneering solutions to additional challenges like:

- Encouraging occupants to return to the city and to offices after the Covid-19 pandemic.
- 'Electrifying' buildings — getting them zero-carbon and electric-car ready by incorporating more battery storage and renewable energy infrastructure.

Building controls and data strategy are core to the success of all this, which has led to strong, trust-based relationships between large building owners and those MEP (Mechanical/Electrical/Plumbing) contractors that have risen to the call to expand their practices into OT networking, open protocol building automation and digitalization. Conti Corporation is one such multi-trade firm who is working to deliver on on-going contracts for IT/OT services to large-building owners in the Midwest.

"50+ floors, 60,000+ points, 6 different protocols, and a multitude of control lines. We need to put this jigsaw together in a way that is unified and useful to building operators. Harnessing the Niagara Framework® has allowed us to simplify the complexities of building automation."

-- Mitchell Reed
Division Manager
Conti Corporation

Challenge

Mitchell Reed, a Division Manager with Conti, had this to say about a retrofit project involving a skyscraper property and adjoining buildings in a downtown plaza: "The customer asked us to standardize their Building Management System (BMS) deployment across their

campus portfolio, allowing the operators to have a single pane of consistent glass to operate the facilities. The overarching challenge for this project was the sheer size of the integration. We needed to accommodate data from all the equipment and devices serving more than 50 floors of diverse space utilization — including open office space, restaurants, and plant and operations."

This Conti project involved integration to Siemens, Honeywell, Distech, Trane, Circon and Johnson Controls brands, along with a migration from legacy Niagara AX to N4 JACE controllers. Conti also replaced out-of-date proprietary-protocol controllers with open-protocol JACE. In addition to all this integration work, the Conti team needed to develop a graphical user interface to serve as central console into the network.

"Integrating so much existing equipment inevitablyleads to the discovery of mechanical issues present in such a large system," Reed continues, "Half the battle of improving existing systems is in finding and replacing the equipment that has likely not worked properly for a long time. We assist our customers in addressing these issues and we get their buildings back to a stable state. Doing this work requires the continuous building of relationships with customer stakeholders, other contractors and equipment vendors—all while helping our customers reach their goals from an operational perspective."

Solution

Both the Conti team and the customer recognized that one of the first issues that needed addressing was moving to a supported N4 version of Niagara Framework® software and off legacy hardware. Once upgraded, Conti then addressed the data modeling and data layering. Utilizing the Haystack tagging dictionary and ideology allowed Conti to harness the Niagara Framework® to streamline data aggregation. The ability to sort data without going through the painstaking process of reworking existing integrations by utilizing Haystack, offers a value that is immeasurable to the industry.

Results

Completion of this controls retrofit and upgrade to N4 across the portfolio sets this customer up for a regular cadence of software updating going forward, so that these properties always have the advantage of Niagara's newest features and cyber-defenses. Another outcome of the project is that databases originating from more than eight different temperature controls contractors have been standardized—meaning common naming conventions and metadata tagging. To adhere to industry best practice, we used the Project Haystack tagging dictionary, along with a custom dictionary that Conti has developed.

Figure 1. Floor-level metrics allow a secondary evaluation of floor-level conditions, easily identifying any deficiencies in floor-level units or the upstream units serving the floor. From one graphical page, the end user can determine mode, operation and operator overrides that could negatively influence the space.

Conti set forth a standardized system that all contractors adhere to. Mitchell Reed explains it this way: "We wanted to support a data presentation layer that flows like other modern-day applications, providing data with understandable names and not acronyms. When an operator navigates the buildings through our GUI, we aim to provide a simple top-down approach, where campus buildings and equipment are rendered consistently.

Whether the downstream device is a Siemens, Honeywell, Distech, Trane, Circon or Johnson Controls brand, the look, feel and operation of the Building Management System is unified and consistent."

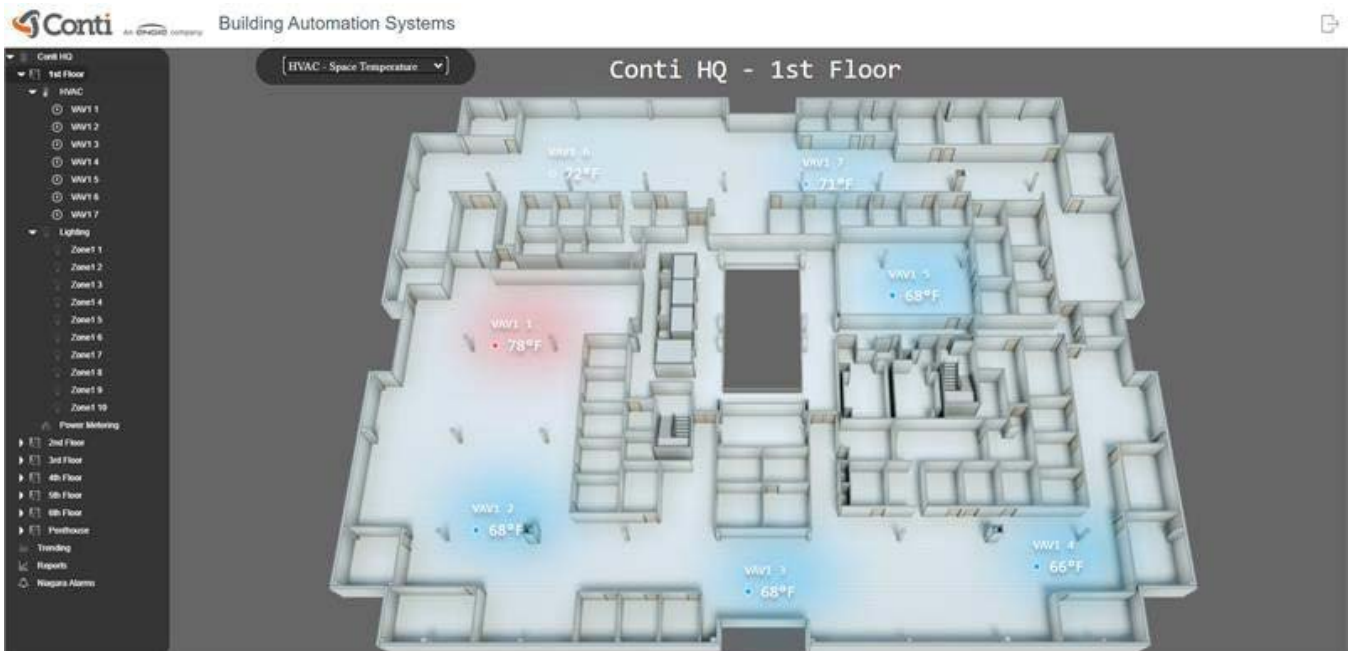


Figure 2. The GUI offers easily interpretable information starting at the 3000-foot view. For example, from this heatmap view, the end user is able to quickly determine any problem units via a visual temperature indication.

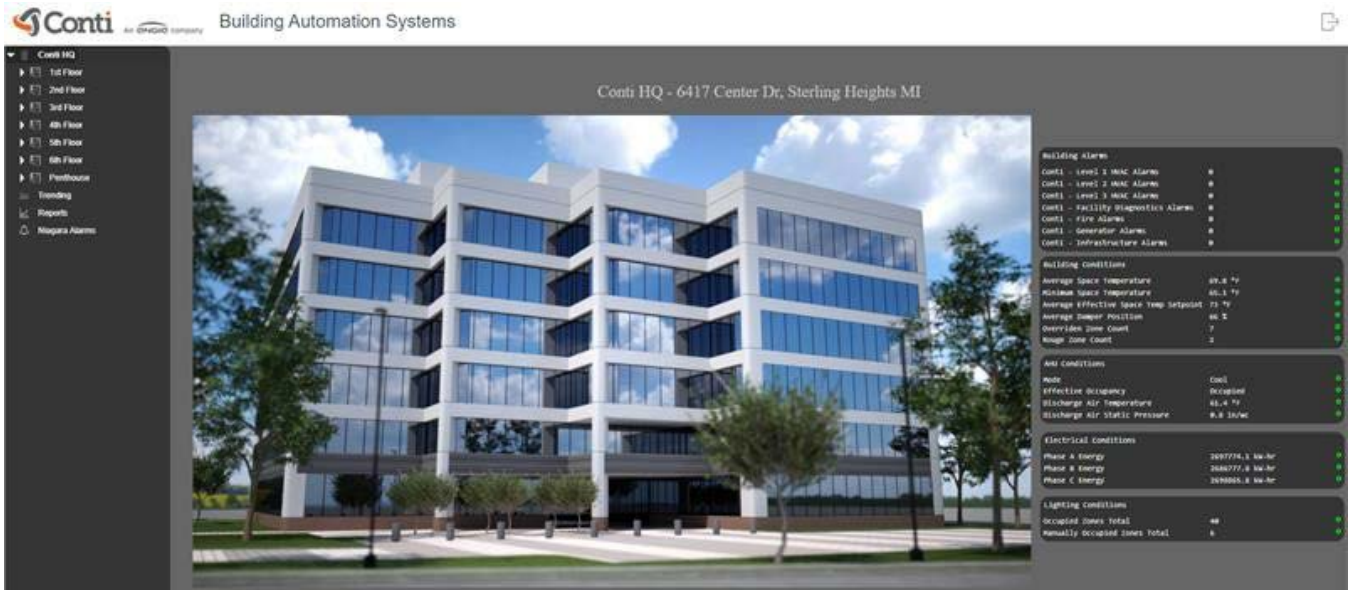


Figure 3. Example of a Conti-developed home screen for a large building. The graphical user interface (GUI) needs to provide for easy navigation from the portfolio-level, to floor-level, down to pieces of equipment and even VAVs Visualizations are designed for easy, unambiguous interpretation to facilitate quick reaction and resolution of alarms.

Conti could count on standardized data interoperability because all these brands support Niagara. And it had great flexibility to customize the user interface down to equipment-level details. Conti needed both to deliver on this particular customer's project goals.

One additional bankable advantage to Conti's openprotocol and standardized data management approach: for future maintenance work, this customer will be well positioned to have jobs competitively bid by multiple temperature controls contractors. The pool of Niagara-certified technicians is so much bigger than that of any individual brand. It has been simply good business all around for anyone that wants to thrive in this era of IT/OT convergence to add Niagara to their skillset.

About Conti Corporation

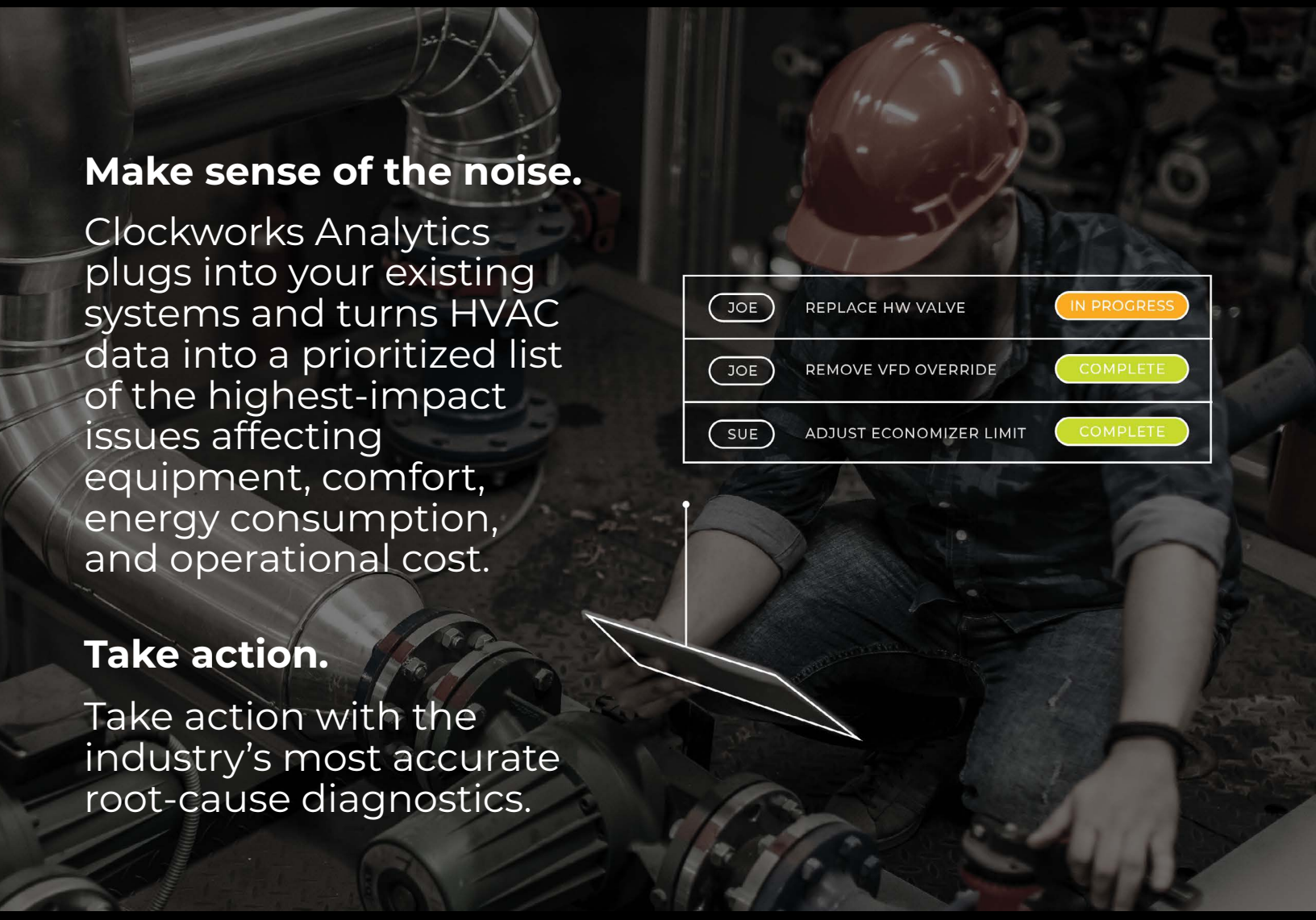
Conti is a nationally respected multi-trade contractor with an impressive history of quality and service. Since 1969, Conti has led the industry in the development of design and construction solutions that address job requirements while surpassing performance expectations. Today, Conti performs the complete lifecycle of construction services from design/build to field installation, training and maintenance for an array of services.

To learn more, visit: www.conticorporation.com.

Therese Sullivan is Director of Marketing at Tridium. Therese has written extensively on the convergence of IT/OT and the Buildings IoT. She is a former editor of Haystack Connections and is a Contributing Editor for AutomatedBuildings.com.

Automated Building Analytics

Don’t just detect. Diagnose.



Make sense of the noise.

Clockworks Analytics plugs into your existing systems and turns HVAC data into a prioritized list of the highest-impact issues affecting equipment, comfort, energy consumption, and operational cost.

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Take action with the industry’s most accurate root-cause diagnostics.

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Tagged Data Analysis Using Machine Learning Methods

ENERGOCENTRUM PLUS, s.r.o.

"Research and practical applications have shown that semantic data are essential, for example, for the scalability of fault detection and diagnosis systems. In the scope of Machine Learning, tags provide necessary information for coupling model data for mathematical models."

There has been a significant development in Machine Learning (ML) and integrating it into numerous fields of expertise in the past few years. We can find multiple applications of ML, for example, in insurance, healthcare, or e-commerce. The energy sector is no exception, and ML is also applied there. This article will focus on the use of tagged energy-related data and ML algorithms.

Research and practical applications have shown that semantic data are essential, for example, for the scalability of fault detection and diagnosis systems. In the scope of ML, tags provide necessary information for coupling model data for mathematical models. A typical example could be the automatic coupling of energy profiles with adequate weather data and occupancy data using tags. This enables the scalability of the developed solution and significantly speeds up the whole process from the model definition to its evaluation.

Following examples in this article will be provided using the SkySpark® extensions Energy Twin (for more information about the Energy Twin extension see https://et.mervis.info); however, these principles are generally applicable.

Modeling Methods

First, we will briefly describe the basic modeling principles focusing primarily on energy use modeling; however, the same model structure can be used for other quantities, as shown in the next section.

In buildings, energy consumption is usually directly related to factors such as outdoor air temperature and the number of occupants. The goal of an energy expert is to design such a model that captures this relation with acceptable accuracy.

The simplest models take into account the relation between outdoor air temperature (or degree days) and energy consumption every month. This model can be easily calculated in Excel or even manually with pen and paper. However, it does not provide much insight, and there can be a significant delay between some anomalies and their detection. Daily aggregations make analysis more powerful, but there are some additional challenges. In the case of daily data analysis, there can be different regimes, for example, working day vs. weekend. Each regime will require a different model.

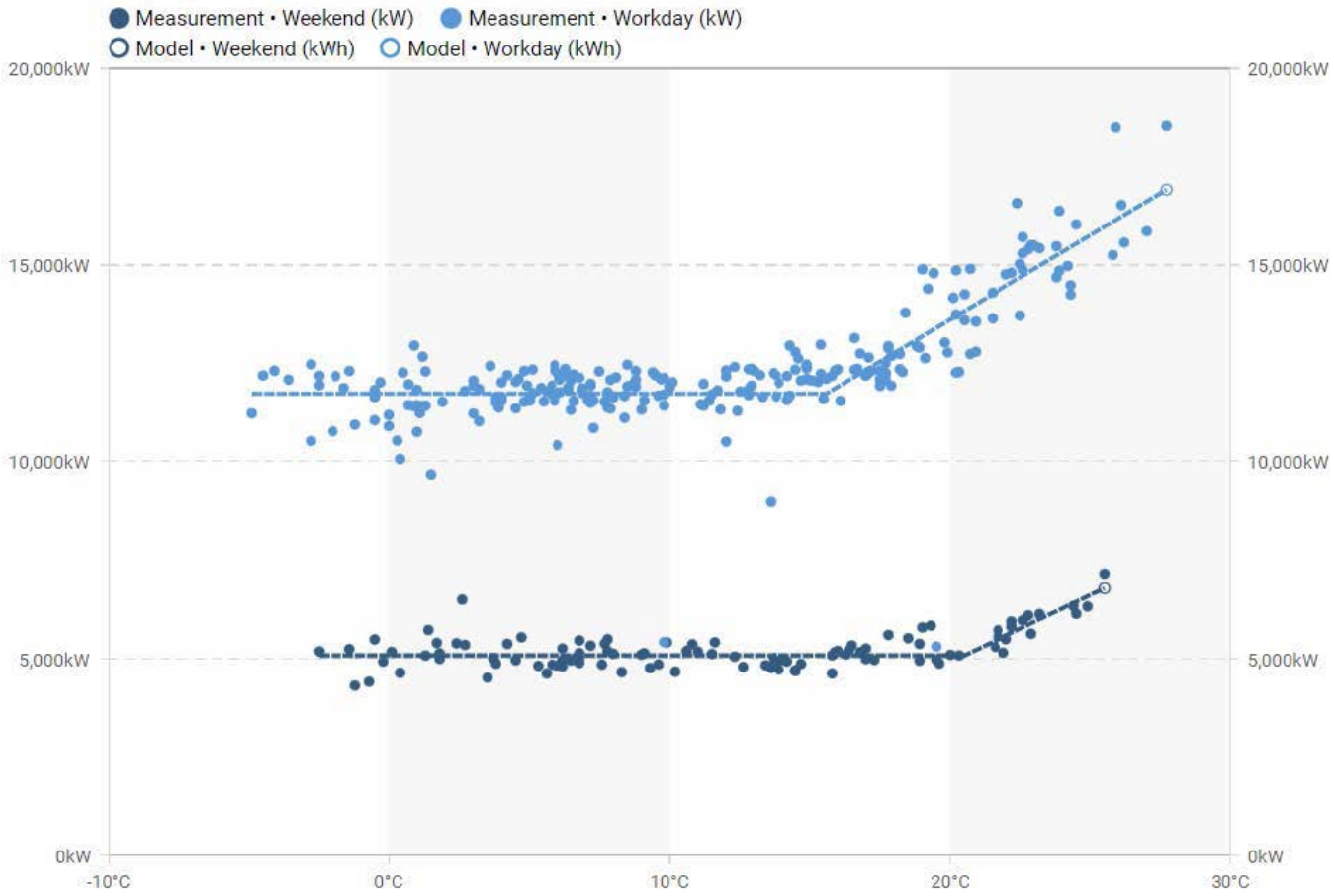


Figure 1. An example of a model with daily aggregation with a significant difference between weekends (dark blue) and working days (light blue). Neglecting the difference between weekends and weekdays would result in a useless model in this case.

Users usually have detailed energy data (e.g., 15-minute samplings) and can ask for a more detailed model than the daily one. This approach can be more challenging because to capture a typical weekly regime within a 15 minute sampling period, and taking into account the weather, such a model has hundreds of parameters. Nowadays, with the current level of technology, this does not pose any computational challenge, and such a model can be calculated using ordinary hardware.

Regardless of the selected model and aggregation period, the procedure is as follows:

1. define training data set and model parameters
2. remove outliers from the training data set
3. train the model
4. validate results (R2, CV(RMSE), NBE),
5. use the model for estimation (historical data), or prediction (future)
6. (optional) re-train the model using newer data sets if needed (automatically or manually)

Use Cases

This section will list some of the possible representative examples providing a basic overview of the use of mathematical models in the energy sector.

Monitoring-based Commissioning

Online measured data can be processed using models to detect significant deviations from standard behavior immediately. There are various reasons behind detected anomalies: local heaters installed, air doors manual regime override, or a wrong setup of an electrical meter. Some of them could remain undetected until a routine check-up is needed, resulting in unnecessary building operation costs. Regardless of the building portfolio size, an expert can supervise buildings more efficiently and identify anomalies almost immediately when using ML.

Some of the possible metrics used for anomaly detection are:

- absolute value deviation (e.g. measurement is higher than model prediction + 50 kW)
- relative value deviation (e.g. measurement is higher than model prediction +20%)
- difference integral deviation (e.g., the cumulative difference between measurement and model prediction is higher than 5 MWh over the last 7 days)

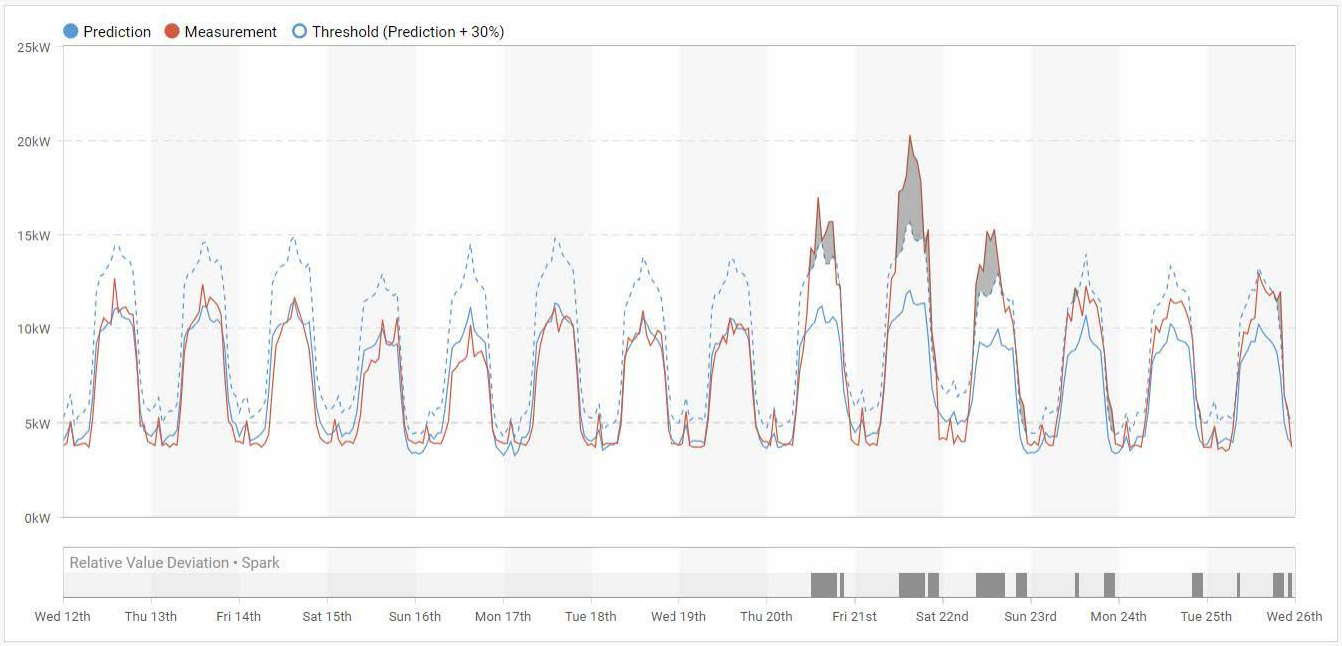


Figure 2. An example of anomaly detection using the relative value deviation (+ 30%). During the first eight days, the prediction (blue line) matches the measurement (red line). On Aug 20th, an anomaly occurred resulting in an exceeded threshold (blue dashed line, i.e., prediction +30%).

So far, we have focused on energy data only; however, other quantities can be used for modeling as well. Water consumption can be conveniently modeled if more occupants are in the building. Let's illustrate the situation in the following example. A model was used to identify typical water consumption in kindergartens to detect any abnormal consumption. The model appropriately learned all peaks in water consumption (snack, lunch) and setback periods. The advantage of this approach lies in no need for defining and tuning thresholds for different time periods. One only has to define the threshold as deviation from the "usual" water consumption profile.

A completely different example is modeling the temperature of domestic hot water at student dormitories in Prague. The models have acceptable precision, and any deviation from a typical DHW temperature profile is easily identified. Much to our surprise, ML also learned the regular system overheating on Saturday morning for Legionella prevention. Learning the regular overheating on Saturday was particularly useful for anomaly detection as illustrated in ***Figure 3***.

Figure 3. Measured and predicted temperature of domestic hot water. On Saturday morning (the black arrow), one can see an expected rise in temperature due to Legionella prevention; however, there was no rise in the measured temperature profile (red line) due to the wrong schedule setup.

Measurement and Verification

In energy-saving projects, it is necessary to evaluate the amount of saved energy rigorously. A model can be trained using data from the baseline period (e.g., before modernization). Then, it provides an instantaneous estimation of "how much energy would be used if no change was done."

In order to use models in the M&V project, there are specific requirements for the models' statistical properties to be met. Therefore, it is crucial to be aware of the statistical properties of the identified models before making any conclusions.

Training Peri...	A...	R^2	CV(RMSE) ▲	PointRef
2019		0.865	22.94%	
2019		0.86	23.32%	
2019		0.783	23.44%	
2019		0.924	23.61%	
2019		0.783	23.77%	
2019		0.628	24.04%	
2019		0.503	24.3%	
2019		0.817	24.74%	
2019		0.885	24.76%	
2019		0.841	25.0%	
2019		0.822	25.14%	
2019		0.876	25.56%	
2019		0.886	25.65%	
2019		0.597	25.89%	

Figure 4. Administration view with models list including statistical properties of identified models. Models with both R2 and CV(RMSE) colored green meet the M&V project's requirements according to the IPMVP and ASHRAE 14 guidelines.

After assessing statistical properties, we can use models to evaluate for example the impact of Covid19 on energy consumption. In such analysis, the models are identified using data from 2019. In other words, 2019 is a baseline period. Modeling allows us to evaluate profiles for each period, compensating for the effect of the different outdoor temperatures and predicting the energy consumption with real weather conditions. We then compare the difference between measured data and model prediction.

Meter	1st wave - spring 2020	Loosening - summer 2020	2nd wave - autumn 2020	3rd wave - spring 2021
Shopping mall 1	-51.5%	-7.3%	-51.9%	-47.9%
Shopping mall 2	-32.2%	-8.5%	-24.9%	-30.7%
Shopping mall 3	-60.4%	-3.9%	-44.1%	-35.4%

Figure 5. Table Comparison of the impact of Covid19 on energy consumption of three shopping malls. Numbers express the degree of energy consumption reduction compared to 2019 for four different Covid19 related periods.

In ***Figure 5*** you can see the example of three different shopping malls and their energy consumption during lockdowns and restrictions. There was a significant energy consumption reduction during lockdown periods. While almost typical consumption was measured during summer 2020 when the government loosened the restrictions. Despite the same lockdown measures, significant differences in energy consumption among the shopping malls can be observed. Shopping mall 1 maintained almost the same level of energy reduction (-52%, -52%, and -48%). On the other hand, we can see a continuous drop in energy reduction in the case of Shopping mall 3 (-60%, -44%, and -35%), which resulted in energy overconsumption of 159 MWh per month compared to spring 2020. For more detailed analysis, read the published case study '**Evaluation of Covid 19 Impacts on Energy Consumption Using Energy Twin Machine Learning in SkySpark**'.

Forecast of Energy Consumption

The models can also be used to forecast the future energy consumption profile, typically from a few hours to a few days ahead. The expected energy consumption profile can be utilized in many ways. For example, using models and their predictions, one can optimize the charging of electric vehicles with respect to the maximum power capacity.

This approach was also used as a part of a control system of a CHP (combined heat and power) virtual power plant. The model provides the expected energy consumption profile of hundreds of flats connected to the district heating system. The goal is to prevent exceeding the contracted daily maximal gas consumption. The prediction is updated every hour, and notification with detailed information with suggested actions is sent in case of the risk of exceeding the contracted maximum. The local technicians do have clear information about the impact of electrical energy trading within the CHP virtual power plant on their district heating system and can react accordingly if needed.

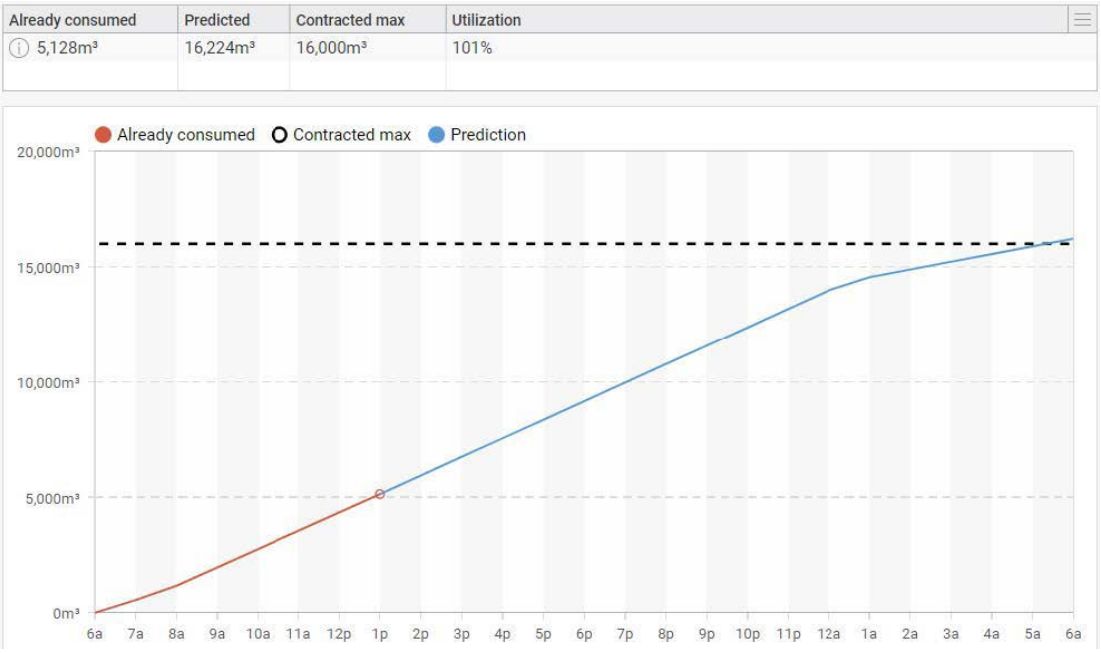


Figure 6. Gas consumption prediction used in the CHP virtual power plant control system. The model is used for periodic updates of the estimation of the daily gas consumption. The predicted daily gas consumption is slightly higher than the contracted daily maximum in the screenshot above. Therefore, the local technicians need to take some action to reduce the expected gas consumption (for example, they can prioritize the boiler over CHP).

The last example is related to PV panels and the concept of prosumers (an individual who both consumes and produces). There are numerous software tools for PV monitoring and management. However, these tools focus on panels only. Using models described above, it is possible to model a building's consumption (e.g., as a function of time and air temperature) and PV production (function of solar irradiance) and gain insight. As a result, one can model and predict total energy flow from and to the grid combining estimation of own consumption with estimated PV production. Such energy flow prediction can be valuable for optimizing battery charging strategy or scheduling flexible loads.

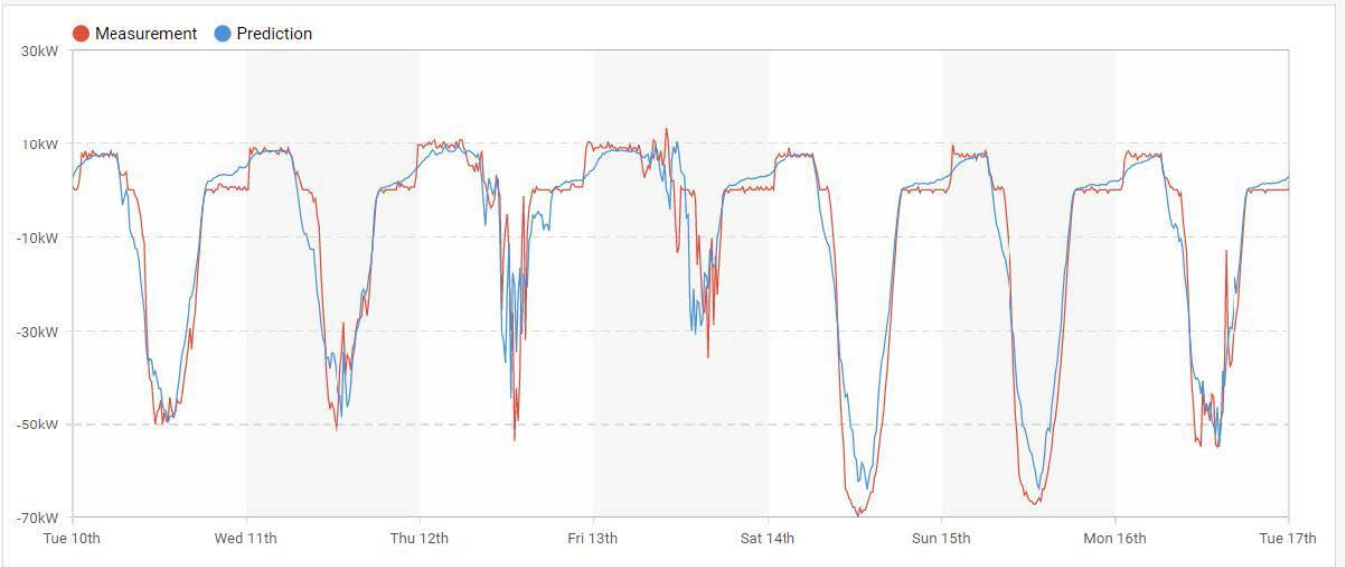


Figure 6. The prediction of total energy flow of a workshop with PV panels in Australia. Negative values indicate flow to the grid, while positive values indicate import from the grid.

Conclusion

The added value that brings tagging of convenient ML for energy data evaluation are:

- Scalability - from model identification and validation to online data evaluation, can be done regardless of portfolio size.
- Objective and systematic - the comparable result, no human error.
- Ease of use - you do not have to be an ML expert to make use of ML.

The most significant added value of ML used with tagged data is in the case of a more extensive buildings portfolio. With just a few clicks, one can obtain hundreds of energy models and avoid time-consuming work in Excel and many potential copy-and-paste related errors.

Using ML for analyzing a building portfolio makes it possible to maximize the human experts' efficiency and take care of the mundane part of the job. ML is not here to replace energy experts. It shall make them more focused on essential matters.

Jan Široký is the leader of the Energy Twin team that is focused on the use of machine learning for energy and HVAC data analysis. He is working with semantic data in various practical applications such as HVAC fault detection or virtual power plant monitoring.

Project Haystack…The Foundational Framework For Data Streams

DLRGROUP

"The Haystack framework allows us to expand and change the data model as needed for each client. For instance, we can add support for new IoT sensors, expand our reach to energy, and even integrate BAS data all without the need of re-designing systems. "

Most building operators and owners are sorting through the dozens if not hundreds of smart-building options to help them navigate the demand for building data to quantify energy usage, air quality, and a host of other data sets. sonrai IAQ by DLR Group™ is an intelligent analytics platform that collects, organizes, visualizes, and analyzes building performance data which optimizes air quality, occupant comfort, and energy use.

Project Haystack is the foundation of this platform that allows it to direct multiple data streams into a single organized flow of information. And this foundation communicates building data from three perspectives of the Building Owner, the Facility Manager, and the Building Occupant.

Sensor Agnostic, Future Proof

Using Project Haystack for data interoperability is a key differentiator for sonrai IAQ. The IAQ sensor market from various manufacturers doesn't allow sensors to communicate data into one stream. Having the ability to integrate, tag, and organize all of these disparate sensors together is key to the sonrai IAQ platform. Standardizing the API allows the platform to utilize the same data in many different ways.

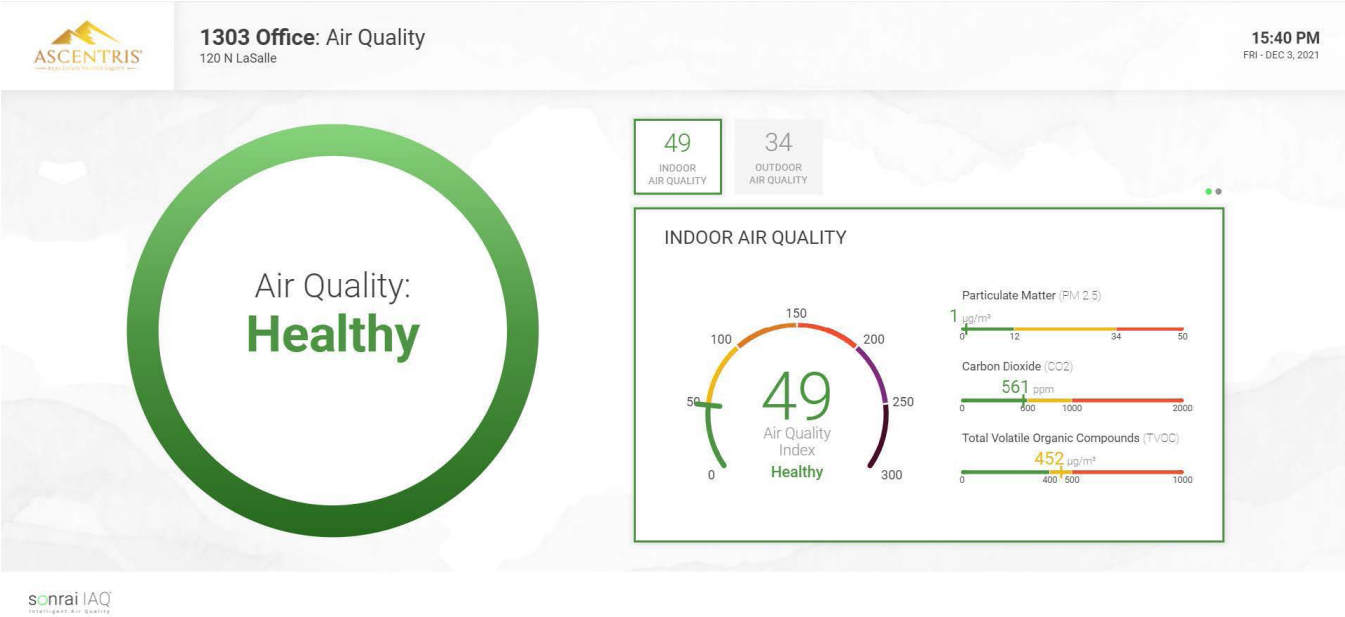
The Haystack framework allows us to expand and change the data model as needed for each client. For instance, we can add support for new IoT sensors, energy management systems, and even integrate BAS data all without the need of re-designing systems. This allows us to future-proof to stay current with the market developments and new products, while meeting the client's needs.

Customer Focused Visualizations

With a standardized data model and API, the building data can speak to each customer persona according to their individual perspectives – building owner, facility manager, or building occupants.

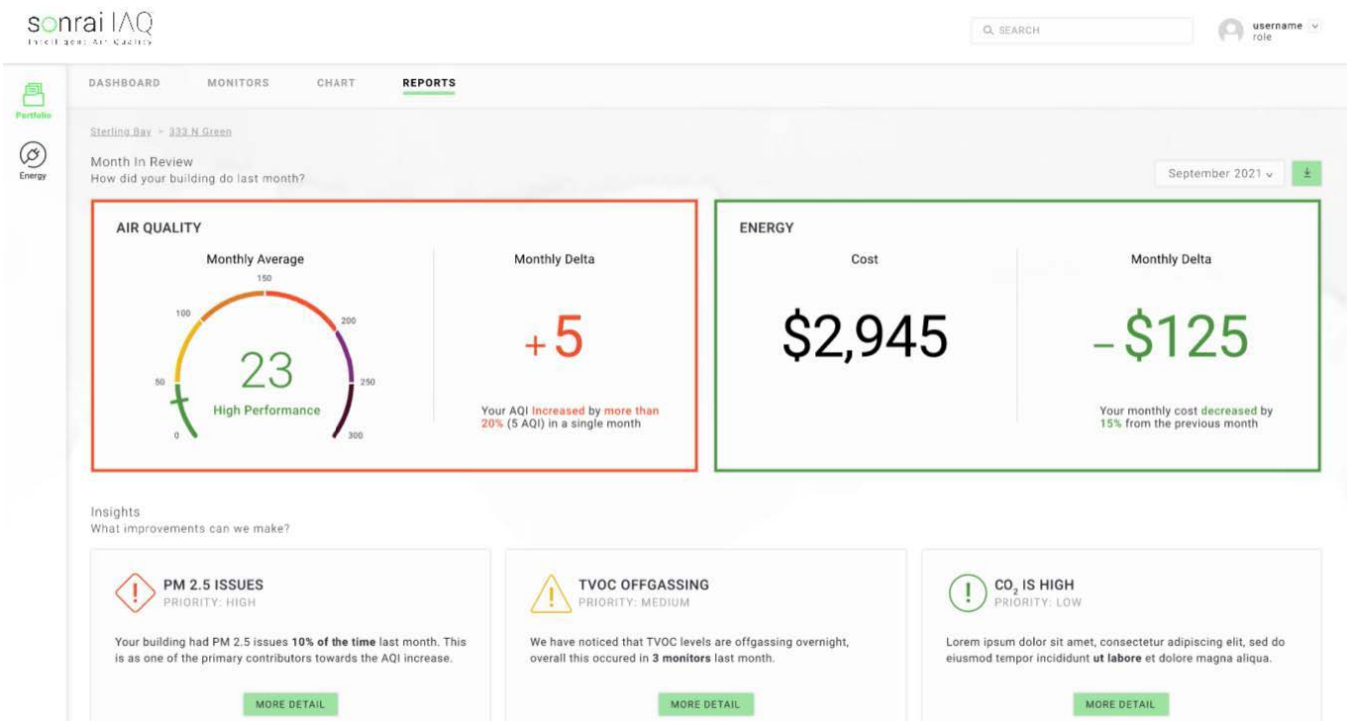
Building Owner

- **Perspective:** A new hybrid work model may produce inconsistent occupancy patterns and energy usage. As the world changes, owners need to find ways to dynamically respond to the built environment because it translates directly into bottom line occupancy rates.
- **Response:** Summarized, easy to understand data can be fed into multiple data sources, such as: Environmental, Social and Governance (ESG) Reporting, sustainability certifications and intelligent automations. A rich data model, like the one created with Project Haystack, takes the client beyond a dashboard of information, creating a contextual bridge between healthy building metrics and energy data. In addition to being a RESET accredited data provider, sonrai IAQ also supports Fitwell and WELL certifications, and uses this new dataset to create a smarter built environment (such as pre/post occupancy purge sequences based on TVOC / CO2 values).



Facility Manager

- **Perspective:** Facility managers are pressured to implement extreme measures to provide high quality air to the building environment. However, they have no visibility into the indoor air quality of said environment. Many IAQ sensor manufactures offer their own bespoke and walled-off data environment. Choose the wrong sensor and the facility manager is stuck with a large number of sensors that don't connect to anything except their own cloud.
- **Response:** Easy-to-understand dashboards help building managers visualize how their enhanced sequences are affecting the quality of the air inside the building. The enhanced sequences help intelligently control building systems based on the quality of the air. Real time and historical performance dashboards create actionable intelligence through interactive charts and automated analytics. These tools identify trends, detect anomalies, and diagnose solutions. Weekly reports summarize performance and actionable intelligence for optimization, equipping the facility manager to respond quickly, armed with the knowledge needed to make smart decisions.

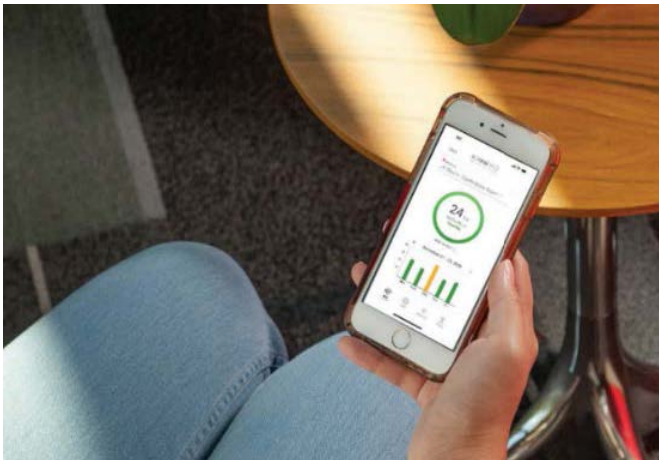


Building Occupants

- **Perspective:** Building occupants want to know if the air in their office is healthy. This information can be used to help inform decisions about whether they will go into the office or work from home that day. Today's workers flex their location based on how they can optimize their time and tasks. Now staff have access to air quality, occupancy levels, and other data. This helps establish trust in the health of the workspace and in the building operator.
- **Response:** Data provided for building occupants needs to be easy to digest and understand in a short amount of time. Providing access to this data via a mobile app, lobby kiosk or by integrating into an existing tenant engagement application are key steps to creating equitable transparency for all key stakeholders.

Whatever the perspectives, everyone needs organized data to assist them in how they do business. And regardless of differing needs, a smart and healthy building leads to improving the human experience directly connected to the built environment.

Photography by Randy Braley



Photography by Randy Braley

Phillip Birch is the product manager for sonrai IAQ™ by DLR Group, an intelligent analytics platform that collects, organizes, visualizes, and analyzes building performance, allowing clients to optimize air quality, occupant comfort, and energy use.

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Need for Scalable System Interoperability

PADI

CloudBlue

"Semantic interoperability provides significant value within and between interdependent domains. Our focus here is to characterize and design a mechanism to make all systems interoperate regardless of their underlying domain scope."

Interoperability is a core concept of computer systems and networks, denoting the ability to discover, connect, and interact with other entities within an application's broader context. In today's distributed computing paradigm, efficiently achieving interoperability at all levels of the technology stack is paramount to deriving the most benefit from a system of systems.

For decades, interoperability has focused on making discrete components work in conjunction with one another. The Internet is perhaps the best example of billions of devices interoperating at technical and syntactic levels in a truly distributed fashion. At a smaller scale, the dynamic discoverability and capabilities matching of a simple USB is another example of the value created through a common interoperability mechanism. The ability to instantly use a device connected via USB with our laptops is an impressive feat of technology that we frequently take for granted.

At a semantic level, Project Haystack has created a tag-based methodology, vocabulary, and ontology that normalizes the description, relationships, and meaning of the various systems, equipment, and devices related to the domain of the built environment including HVAC, lighting, and energy production and metering.

Semantic interoperability provides significant value within and between interdependent domains. Our focus here is to characterize and design a mechanism to make all systems interoperate regardless of their underlying domain scope. The authors believe that the mechanism to make systems interoperate within a domain should be the exact same mechanism as interoperating across different domains. We see this in both the Internet and USB; both are scalable because the fundamental mechanisms are agnostic to domain or applications.

As we discover new applications of digital twin systems for the betterment of business and society, we become increasingly aware of the importance of interoperability. Ensuring that these systems' discrete components and the broader system of systems are interoperable is essential to unlocking their potential with less implementation cost, less risk of failure, and less complexity at scale. In many ways, we strive to create a

framework that would enable USB-type compatibility and ease for all systems connected to the Internet and private networks. Developing such a framework is daunting as most systems perform specific tasks and do not inherently interoperate with outside entities. System integrators typically handle such tasks.

The labor-intensive work performed by the $400B+ global system integration industry is often unnecessary. We argue that we may ease this burden by designing systems around a common framework and utilizing common mechanism(s) to interoperate like USB devices. Doing so empowers those working in system integration to maximize their efforts' value, designing applications that perform as intended rather than through point-to-point integrations.

The Digital Twin System Interoperability Framework white paper recently released by the Digital Twin Consortium provides the framework for such activity, delivering on the authors' aim to characterize the multiple facets of system interoperability. Our descriptions have been distilled into seven key concepts framing the design considerations necessary to make systems interoperate at scale. While the authors may not have contemplated all permutations of system interoperability, evaluating a digital twin perspective within the Digital Twin Consortium has provided the breadth and depth of scope necessary to address this paper's objectives.

We have created a framework capable of unlocking significant value in complex distributed computing systems such as digital twins. As we invite you to review, challenge, refine, and adopt this framework, we hope it proves helpful in designing computing systems that improve our lives.

For more information about the framework, watch the webinar on-demand: **How System Interoperability Empowers Digital Twins**.

To read the white paper from the Digital Twin Consortium, visit: **Digital Twin System Interoperability Framework**.

For more information on the Digital Twin Consortium, visit: **www.digitaltwinconsortium.org**.

Anto Budiardjo, CEO of Padi.io, is a veteran in the connected building space. Since 1989, he has led the development and promotion of building connectivity and integration technologies. Today he is focused on a new venture to bring system integration into the Internet era with an online integration and collaboration platform Padi.io.

Doug Migliori is Global Field CTO at CloudBlue, a digital marketplace development and orchestration platform provider. He has over 20 years of IT consulting experience, applying innovative strategies to digital transformation that leverage digital twin, IoT, AI, mobile, DLT, and cloud/edge native technologies.

The Role of Semantic Tagging in Supporting HVAC Equipment Manufacturers

J2 INNOVATIONS
A Siemens Company

Conserve it

"With Project Haystack web protocol, HVAC equipment manufacturers have the option to implement remote connectivity to the equipment they have supplied on site and monitor performance over time. This has the potential to generate huge amounts of aggregated IoT data across multiple customers for analysis of how their products perform under various conditions."

Today 80% of all commercial buildings do not have a building automation system in place, which means there is an opportunity to reduce energy consumption and minimize their carbon footprint. Given that HVAC is the largest consumer of energy in a building, it is logical that managing and controlling HVAC will make the biggest impact on reducing energy.

As the largest energy consumers, HVAC equipment manufacturers are in prime position to lead the way and ensure that their equipment is efficient while also supporting the optimization of other building components. Using the power of Haystack semantic tagging, HVAC manufacturers can make this possible by creating opportunities for simplified integration and interoperability with third party applications.

Manufacturers have the opportunity to create "system-in-a-box" type solutions for managing their products and related whole building systems. The answer is to enable the HVAC installer to provide simple and data rich building management and plant management type solutions through the power of tagging.

Simple, accessible tech

Imagine equipment manufacturers provide deskilled plug n' play systems and applications which can easily be commissioned by the HVAC installer to create a simplified building automation system that delivers substantial energy savings.

We're reimagining what relationships look like between equipment manufacturers and BAS using Project Haystack and leveraging the power of tagging and data modeling. Here's a look at how the open standard and technology can simplify HVAC equipment control, deployment, and provide more visibility into performance data.

Going beyond the mechanical equipment

The opportunity exists for HVAC manufacturers and their installers to go beyond the basic safeties and control of just the singular HVAC equipment. They could provide a complete, integrated HVAC system that includes the air handling units, chillers, boilers, pumps, cooling towers, and associated valves and sensors. This holistic approach

can then help optimize the performance of the system as a whole to save energy and operating costs. While the value of such integrated solutions is well-known, today's challenge is largely the "spaghetti integration" of different devices with their own semantic models and sometimes even protocols.

Provisioning and startup

What if deploying an HVAC system was a matter of an installer entering basic configuration parameters through a wizard? With the help of a software appliance approach, a step-by-step process could be taken to provision an entire system. This configuration could even be done in the factory production line or remotely via a commissioning engineer as well.

The plant equipment controllers will self-identify ("I'm a chiller", "I'm a boiler", etc.) and auto-generate their own Haystack tags. The controller will also announce the points it contains by publishing a tagged, semantic model.

This would result in a product that provides a foolproof way to deploy a complex system with the OEM's control and optimization knowledge built right in. Therefore, the overall performance and reliability would be maximized from the day it was started up.

Integration

The resulting tagged applications provide value to both manufacturers and third-party applications. By sharing the structured data, the plant system becomes part of an open and integrated solution. High value applications such as analytics, dashboards, trending, historian, and alarming can now consume the data more easily. This enables enterprise level data comparison and analysis across multiple vendors and systems.

Control engine

For HVAC equipment, the control system integrates and orchestrates the components of the fans, motors, dampers, actuators, and sensors. These inputs and outputs are modeled and tagged using the Haystack standard and can be dynamically linked to a control engine that implements the automation and optimization strategies. Through tagging, the defined control strategies can be mass deployed to all systems of such type without extra engineering. This can extend beyond the plant logic to incorporate associated equipment, such as AHUs, FCUs, HPs, and VRF systems. With a tagged system, the manual task of linking censored data is replaced with dynamically linked data queries.

Enhance your equipment's UI

The user experience (UI) can influence the ease of deployment and overall quality of the provisioning. Through the use of a software appliance (typically on a touch screen or mobile device), the procedure for check out and system startup is a better and more productive experience. For installers, this helps streamline the commissioning process and also makes it easier to integrate into the building automation system.

When implementing a system based on Project Haystack standard for point definitions, the binding of the data to the user experience widgets happens automatically. This creates automatically generated graphical content and dramatically reduces engineering labor.

Performance data

HVAC manufacturers generally have zero visibility around their equipment set-up or performance - unless it malfunctions and one of their own technicians has to be deployed to physically diagnose the problem.

With Project Haystack web protocol, HVAC equipment manufacturers have the option to implement remote connectivity to the equipment they have supplied on site and monitor performance over time. This has the potential to generate huge amounts of aggregated IoT data across multiple customers for analysis of how their products perform under various conditions. These kinds of insights could help identify optimization opportunities and make software updates automatically. It also allows benchmarking against other equipment, be it legacy models that were replaced.

Project Haystack provides the means for equipment manufacturers to unlock new revenue streams and position themselves for the new data driven economy in the building systems world.

It's time to make an impact

With a Haystack enabled system, an HVAC equipment manufacturer and installer can collaboratively create better systems to ensure maximized plant performance. The manufacturer provides embedded control knowledge and optimization strategies for their product. Their appliance helps standardize the complexity of a central plant, and provides normalized data for easy consumption. For the installer, this means they can deliver an integrated

intelligent building project with confidence. For the HVAC equipment manufacturer and their ecosystem partners, the Haystack tagged data allow for new business models around higher value software applications and services. Ultimately, this provides a better user experience for facility managers, energy managers, technicians, and end users.

It's time for manufacturers to seize the opportunity and create "system-in-a-box" type tagged and IoT ready solutions for managing their products and associated ancillary equipment. Forward thinking manufacturers are already building Project Haystack into their equipment. Those who don't seize this moment will be left behind and left out of the power that semantic modelling technologies such as Project Haystack offer.

Alex is a designated Board Member of Project Haystack and is an active member of the Haystack community. Alex joined J2 Innovations in 2018 from Siemens and as CEO brings his passion and expertise in building automation software, corporate strategy, portfolio management and OEM sales to the company.

Richard McElhinney is the Vice President of Technology at Conserve It. Richard has over 25 years experience in product and solution development having worked globally with leading companies in the Smart Building Services space.

Cold Storage Facilities and Refrigeration Loops

buildingfit

"CBRE reported that they estimate 100 million additional square feet of cold storage warehousing will be needed over the next five years. To meet the demand, and maintain energy efficiency, cold storage facilities will need to be modelled, data tracked, and ultimately brought into the modern data driven world."

Cold Storage Facilities have seen their demand increase steadily throughout the 2000s. However, with the advent of more online delivery systems, the need for more facilities is skyrocketing. CBRE reported that they estimate 100 million additional square feet of cold storage warehousing will be needed over the next five years [1]. To meet the demand, and maintain energy efficiency, cold storage facilities will need to be modelled, data tracked, and ultimately brought into the modern data driven world. In this article we will focus on our approach to tackling the refrigeration systems present within the facilities, allowing us to apply analytics and improve efficiency.

Cooling cold storage facilities still require the basics of the refrigeration cycle. However, unlike a traditional chilled water plant, cooling facilities will break up equipment into subsections. Instead of having a chiller that provides the compressors, evaporators, and expansion, these pieces are broken out across an entire refrigeration loop. This allows for more modular control of the amount of cooling that is being supplied. Most systems will have multiple loops, and some redundancy to apply to any loop that is struggling to meet demand. Finally, the loops will server areas, like spaces, but the space is usually in the form of a refrigeration case. There are various configurations for these systems, however, we will focus on a single configuration, then talk about how to expand beyond that.

To start, we will look at an overall system. Each system will have a series of compressors, followed by condensers, heat exchangers, and refrigeration cases. The refrigeration cases are typically on a loop past the heat exchangers. As these systems provide refrigerant, not water, we treat them as refrigerant plants. Heat exchangers, pumps, and loops all follow current haystack definitions. The overall plant, compressors, condensers, and refrigeration cases are the unique equipment we will focus on. As a note, this article does not have the specific defs for each of the tags that we are using, it is just an overview of the systems.

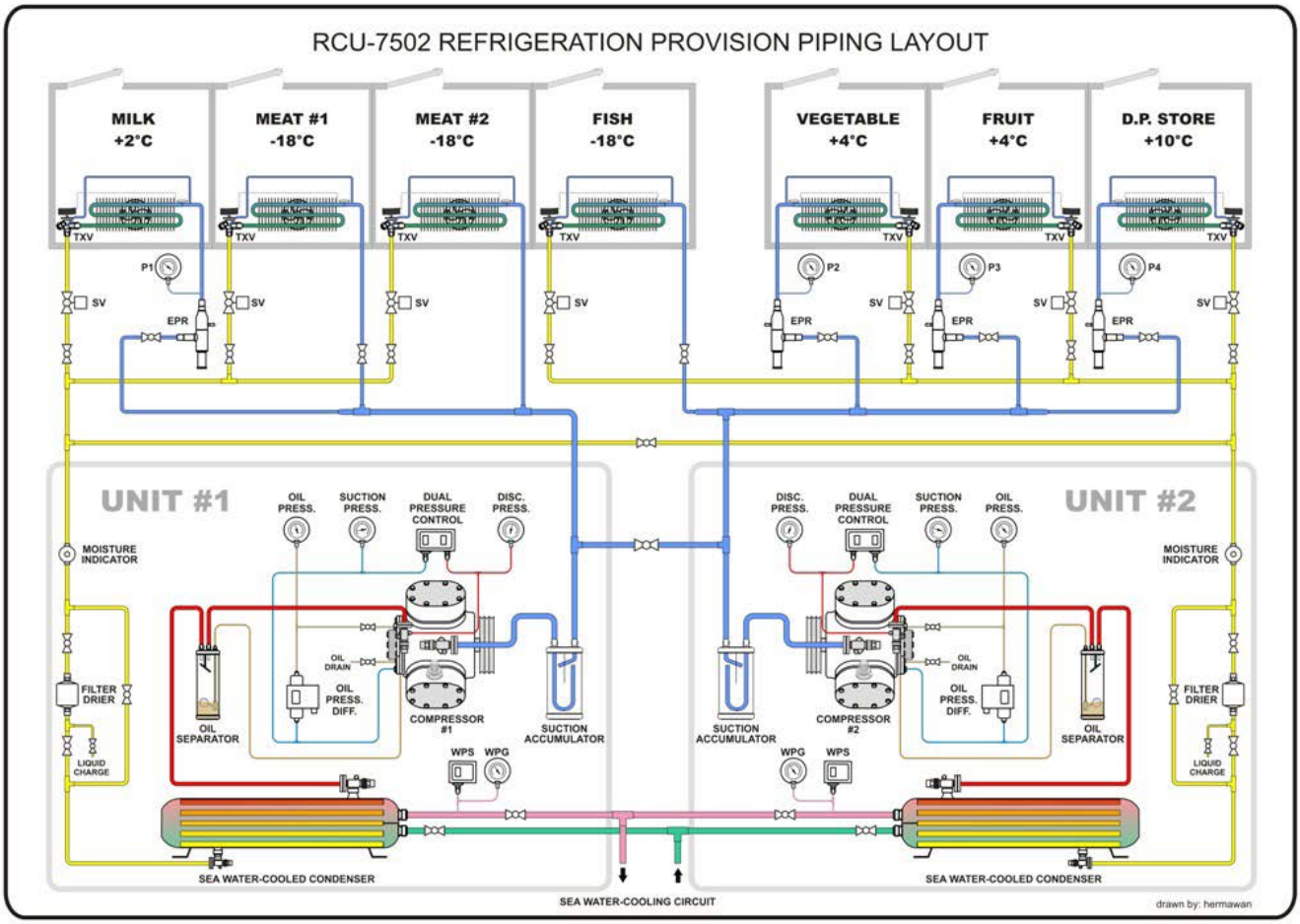

Figure 1. Basic Refrigerant Plant Structure. This gives a general outline of how cold storage facilities can be setup. There are many different configurations, but this provides a base starting point. Diagram from [2]

Refrigerant Plant

Refrigerant plants follow most of the plant tagging, with a few exceptions.

Unique equipment tags:

- refrig

Unique points:

- nh3 concentration sensor
- refrig leaving temp sensor
- refrig entering temp sensor

Other points for control sequences are also defined (setpoints, commands, etc.). The refrigerant and condenser temperatures do allow for calculations on efficiency. We monitor that efficiency for each plant. We also bring in the ammonia sensors, which are critical for maintaining plant safety.

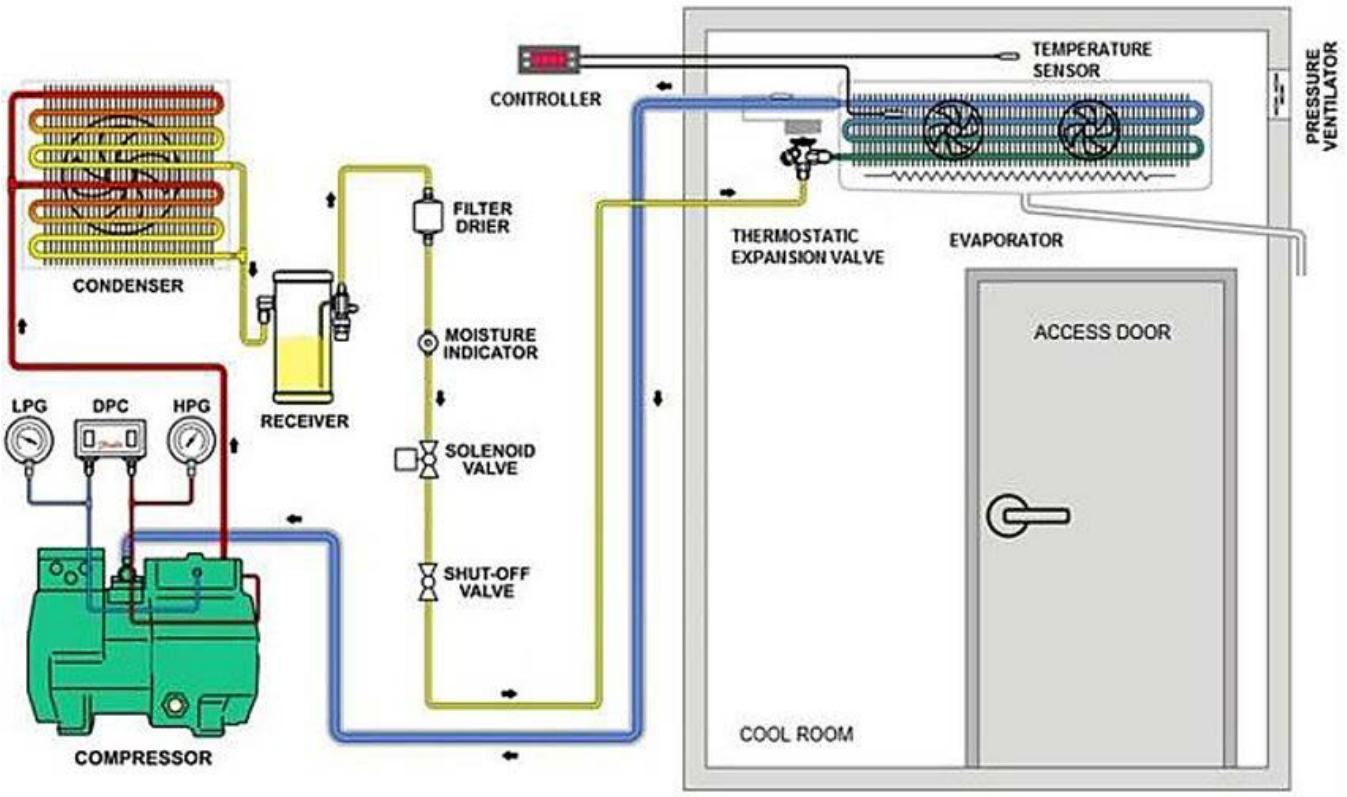

Figure 2. Basic design of a cold room and compressor system. The condenser and compressor are separate in this model, as a key difference between traditional chiller plants [3].

Compressors

Compressors, not surprisingly, contain points typically defined underneath a chiller. We expand on these points that give more insight into the condenser and evaporative efficiency.

Unique equipment tags:

- comp
- compMechanism

Unique points:

- oil pump pressure sensor
- oil sep temp sensor
- oil temp sensor
- cond efficiency sensor
- evap efficiency sensor
- refrig subcool delta temp sensor
- refrig suction superheat delta temp
- suction pressure sensor
- suction temp sensor
- discharge temp sensor
- discharge pressure sensor
- refrig plant supplied sp

The additional points allow us to evaluate efficiency of the refrigeration cycle. We can then build analytics to flag when the efficiency levels are below standard and can allow engineers to diagnose the root cause.

While most compressors will live underneath a single refrigerant plant, cold storage facilities can have swing compressors that will supply whichever loop is currently underserved. This means we can't use a simple reference tag to capture which system is supplied. Instead, we need a historized view. The refrig plant supplied point allows us to understand where the swing systems are active and can consider the added cooling provided. It essentially functions as a mode style point, allowing for better understanding of how the overall system is performing.

Evaporative Condenser

The evaporative condenser functions similarly to a cooling tower. Most points are modelled in the same terms, with fan and vfd metrics outlined. Other forms of heat reclaim were not modelled yet but will be expanded and contained within the refrigerant plant. For a more in-depth discussion on heat reclaiming strategies, see Refrigeration Playbook: Heat Reclaim [2].

Unique equipment tags:

- condenser
- condMechanis

Refrigeration Cases

Refrigerant cases can be treated like thermostats. They are responsible for maintaining a certain temperature within a space. They do have separate modes of operation that we will outline.

Unique equipment tags:

- case
- refrig

Unique points:

- air temp sensor
- air temp sp
- refrig temp sensor
- refrig mode sp
- fan sensor
- door sensor

The first check for any analytic is the maintaining of temperature setpoints. Is the refrigerant case able to adequately maintain temperature? Next the refrigeration

mode can vary, from defrost to refrigerate. Finally, several checks on the fan circulation and a basic door check for the door switch gives a complete picture of how a refrigeration case should be operating.

Applied Analytics

As this is the early stage of development, our supported analytics used for diagnostics are built for engineers to be able to evaluate multiple facilities and plants. Our fault detection involves checking the efficiency of each system and component of the refrigeration cycle, identifying when they are not performing. We also can evaluate and compare the different plants, loops, and equipment.

In the future we hope to use the increased visibility provided by the unique points to create quick actionable items for cold storage facilities.

Chris Spurlock is currently a Product Developer at BuildingFit and has worked in the Energy Efficiency industry for nearly 10 years. He has been involved in the Project Haystack community and been focused on making analytics more user friendly for almost as long.

Sean Stackhouse is a lead developer at BuildingFit. His focus has been on improved analytics and applying Haystack tagging to projects. He has been a contributing member of the Project Haystack community since 2016.

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Automated Functional Testing Has Arrived and Yes It Works

epstengroup

"One thing that hasn't changed much in the commissioning of building systems is functional testing. We test mechanical, electrical and plumbing systems to ensure that they function as intended. One could argue that this is a commissioning provider's highest priority."

Adapt or Die. A phrase that has been used to describe many situations including in business. Technological advancements in the past decade alone have changed our lives and businesses in a myriad of ways. The design and construction industry has seen this firsthand, mostly notably with building information modeling, but advancements are happening every day. At Epsten Group, only 10 years ago we were using spreadsheets for tracking commissioning issues with engineers and contractors during design and construction. This seems arcane now that well-established, cloud-based software exists that help with this function and at a fraction of the cost of labor spent managing spreadsheets and email exchange.

One thing that hasn't changed much in the commissioning of building systems is functional testing. We test mechanical, electrical and plumbing systems to ensure that they function as intended. One could argue that this is a commissioning provider's highest priority. And we have done this manually (on the job site in front of the equipment) for decades. This was necessary, and continues to be so, for many systems we are hired to test. However, technological advances combined with standardized naming/identification of data points within building automation systems has opened a door to an automated approach to testing of repetitive, terminal-level systems.

A typical commissioning scope includes HVAC systems and associated controls. Regularly we are tasked with sampling "like" equipment such as terminal units, fan coil units, etc., which are high in quantity on a given project. Our firm works regularly on new buildings with more than 100 terminal units which have application-level controllers on them to perform relatively simple and repeatable functions, modulate for space temperature control, adjust for CO2 in the space, etc. While the sequences and controls for these devices can be quite simple, they both have a direct and indirect impact on occupant comfort, building energy use, and indoor air quality, so they cannot be ignored. However, a sampling rate during functional testing of 100% is often unjustifiable given the quantity of equipment and limited complexity. Therefore, we often sample at some rate between 10% and 30% for terminal devices, which keeps costs down and is statistically viable.

As commissioning agents, we also spend a lot of our testing time on troubleshooting operational issues which extends to these terminal devices. Malfunction

is not saved just for the more complex systems such as centralized air handling units, chiller plants and integrated lighting control systems. But, we are rarely able to account for this time when putting together proposals. Otherwise, our clients might think we are overcharging or believe they can get a better deal from another firm. This presents further opportunity for leveraging the technology at our fingertips to test repetitive, less sophisticated systems automatically and to do so at scale. Haystack tagging, for example, really helps to apply similar analytics across multiple projects by coding the analytics to look for specific tags. From a software development viewpoint, this is very powerful and lowers the cost of deploying automated testing and analytics. As a commissioning provider, we don't have to really understand how tagging works; we simply see lower costs from our technology partner because of the benefits of Haystack data normalization.

Whereas the commissioning agent is typically sitting with a controls technician at some front-end connection and adjusting setpoints to manually check performance, automated functional testing removes this step. If we typically sample terminal units with manual testing, why can't we test every terminal unit with automated functional testing? Now we can. And we have already done so on numerous projects at the end of construction, before owner occupancy.

So how does it work? For new buildings, we connect a cellular-enabled encrypted gateway to the BAS at the network- or field-controller level. That gateway then connects to the cloud where our automated tests live. In our case, we utilize an Automated FPT tool called OTTO, which houses our automated FPTs in a time-based program or sequence. Over the course of several hours, often run at night, our FPTs are executed on terminal devices all at once (or sometimes in smaller batches, but always numerous devices in a given window of time). At the conclusion of the testing, we automatically receive a summary report of the results, including pass and fail steps for each terminal device. And then the analysis begins of the fail steps.

This narrows the focus to the problematic terminal devices out of the 100% sample and expedites the generation of commissioning issues and subsequent resolution by the responsible contractor. Where manual testing might take days, plus time to do troubleshooting, it is effectively cut to a single overnight activity with a significantly improved

sample size. For most commissioning agents, the schedule is not our friend. We are shoe-horned in at the end of the project and gaining back even a couple of days is of tremendous value, not only to us, but also our clients and their general contractors.

Additionally, testing is typically being conducted prior to the client's IT network being in place. Therefore, we have a great opportunity to have early access to the BAS and associated data that we normally have to request from the controls contractor. That data is often provided in simple .csv file outputs that require a lot of massaging to analyze, not to mention it is only a snapshot in time. This arrangement also preempts the often-onerous security requirements needed to access the client's BAS network remotely. However, having the IT network up and operational is not a bad thing, simply another piece of the puzzle. On the case studies described below, we worked through the client's IT networks, which did have security requirements, to satisfy but was done so successfully.

A couple of examples include the recently opened ASHRAE Headquarters in Peachtree Corners, Georgia and the new Academic Learning Center at Kennesaw State University. The ASHRAE HQ project was one of the first where our team attempted automated functional testing and was conducted as a supplement to manual functional testing to verify the potential of the automated FPT approach. The building provides thermal comfort to occupants using radiant heating and cooling ceiling panels across 75 unique zones which are served by an air-cooled heat pump chiller. These radiant zones are repetitive in nature and therefore are ideal candidates for automated testing. Our test scripts were automated in the cloud and overrode the applicable BAS setpoints during the early morning hours to test cooling, heating, and satisfied conditions as well as interaction with the BAS-controlled ceiling fans in each zone. We were able to verify anomalies and failures of individual zones and then focus our attention on those problem zones with the controls contractor immediately.

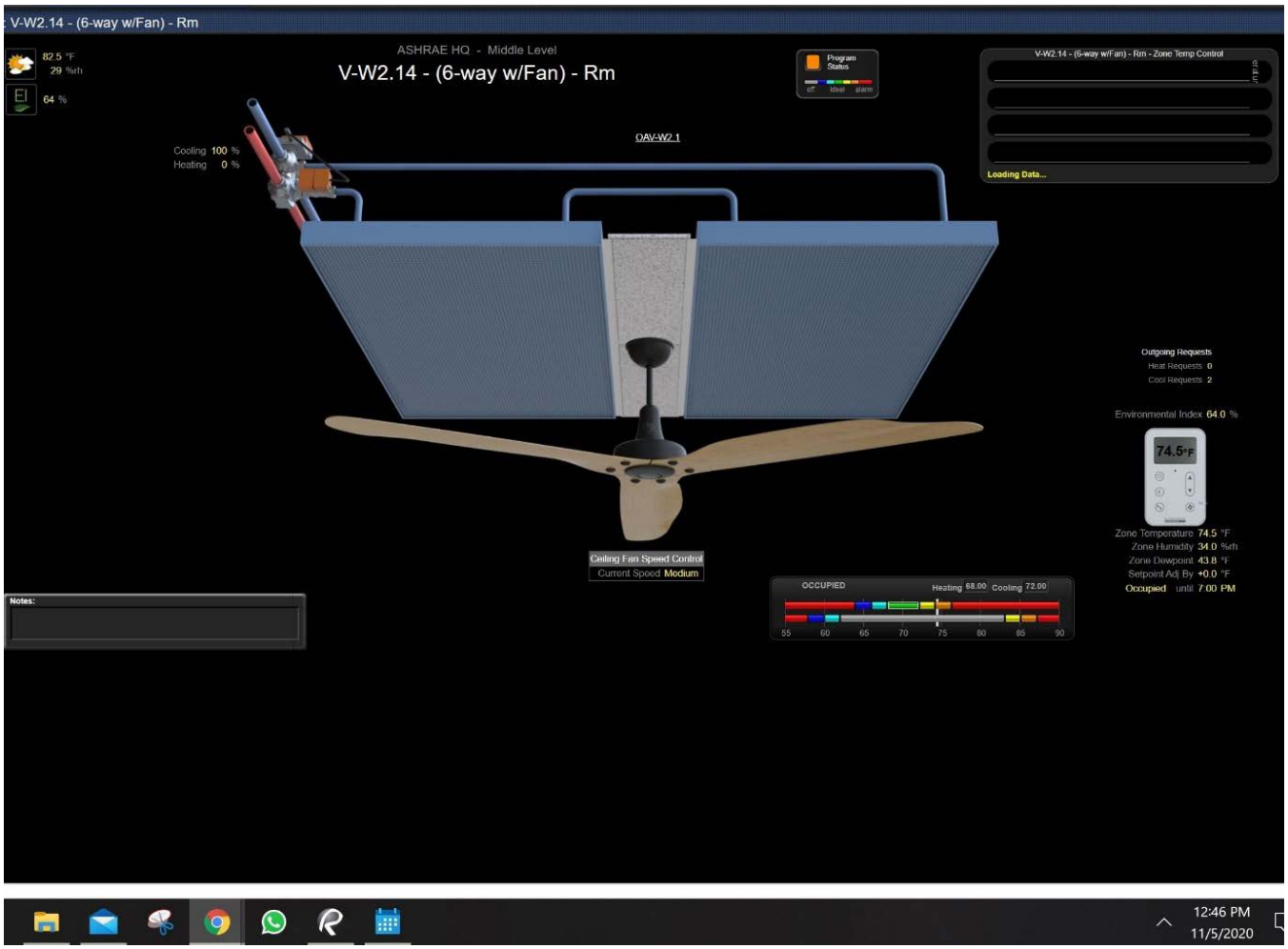


Figure 1. ASHRAE Headquarters: BAS Graphic, Typical Radiant Zone in Cooling Mode Testing.

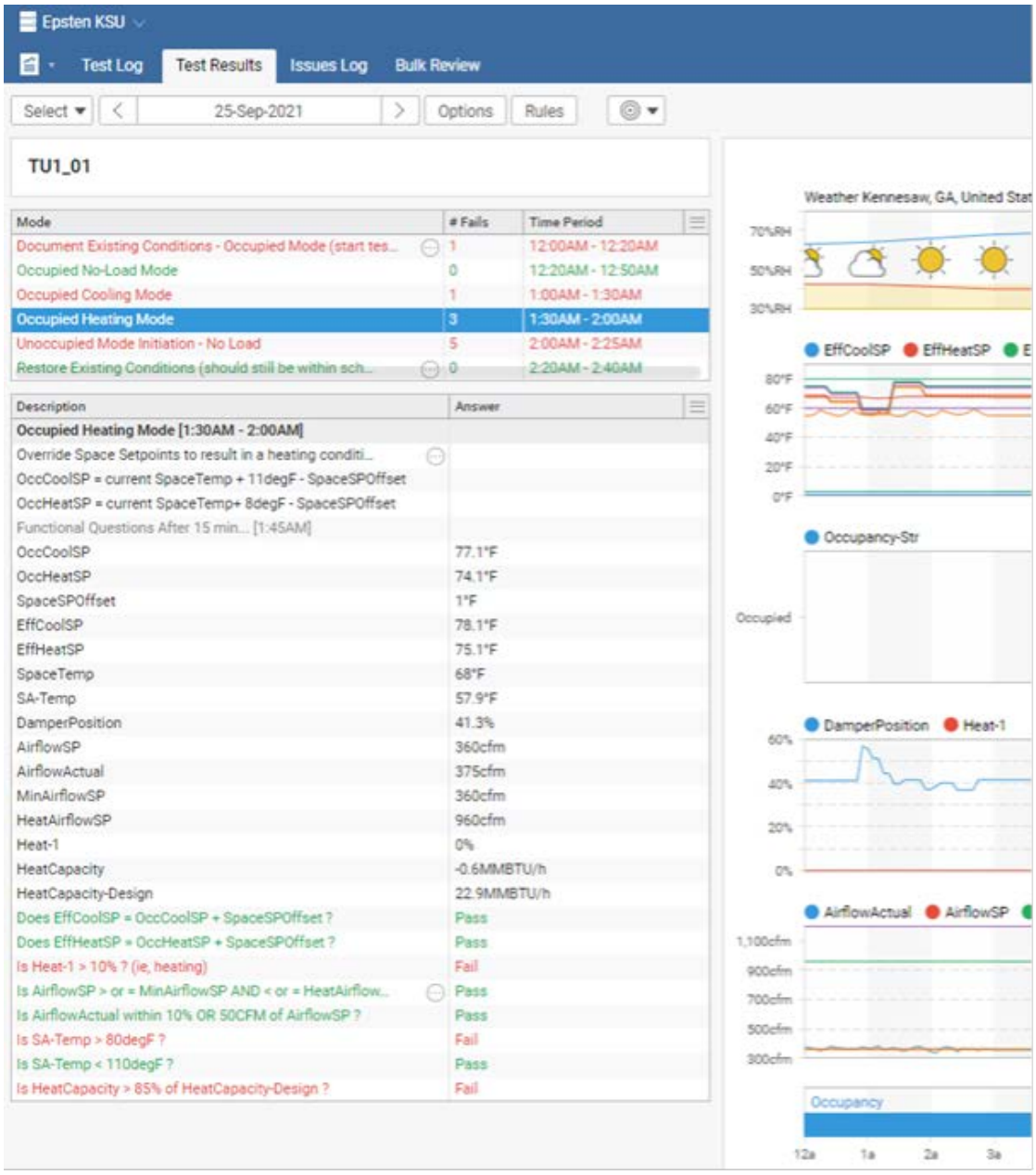
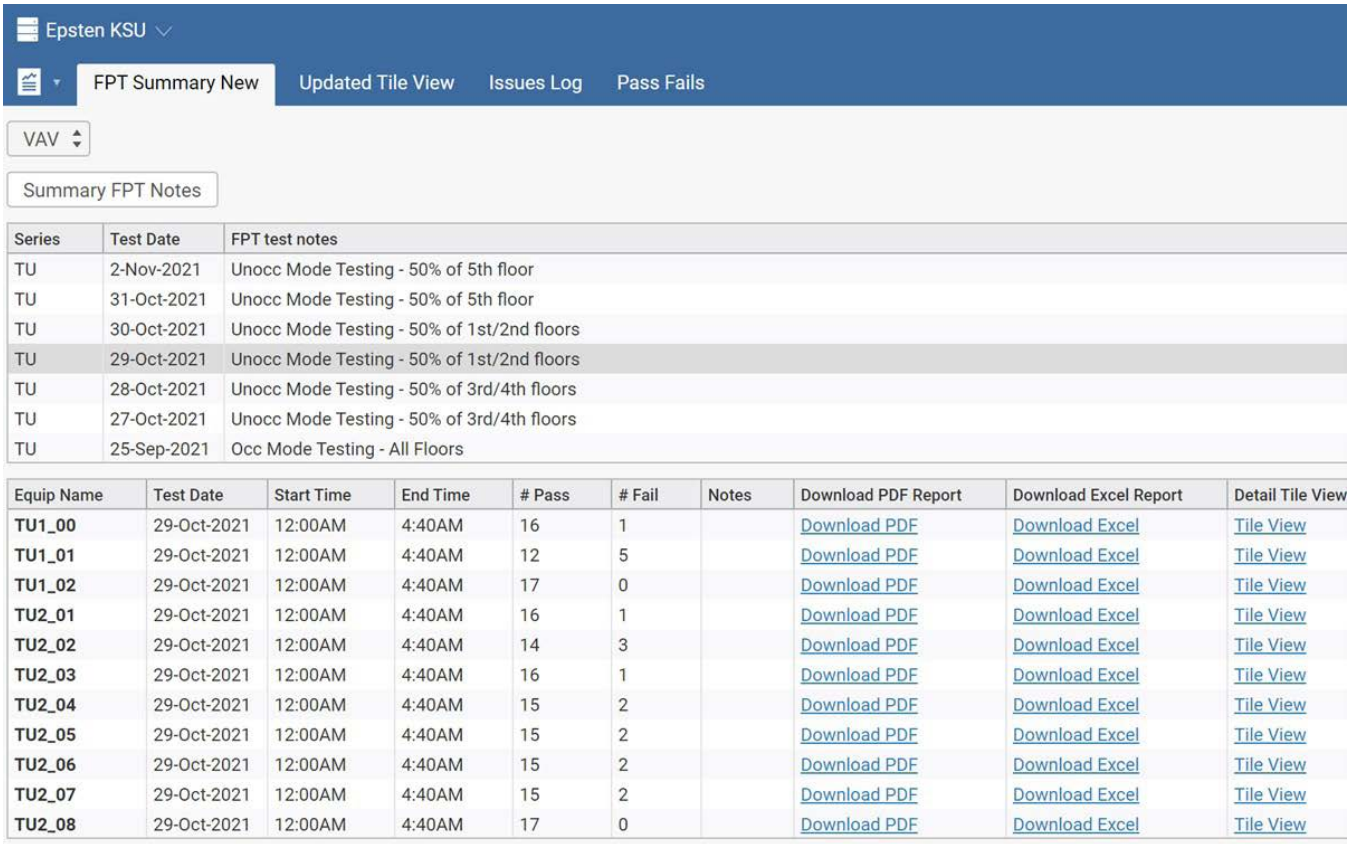


Figure 2. OTTO Test Snapshot for a Typical Terminal Unit

The KSU Academic Learning Center is a more standard HVAC infrastructure with a combination of 122 terminal units and fan-powered terminal units with hydronic reheat all served by central-station air handling units. Testing began prior to the owner's IT network installation and therefore we utilized a cellular gateway for testing on each floor, but the process of testing was the same. The IT network was brought online near the end of our functional testing, and we transitioned to utilizing that network, so this project used a hybrid approach. In the end, all that was required on our part was the analysis of collated test results data and the correlated trend data. See examples at the end of this article.



Series	Test Date	FPT test notes
TU	2-Nov-2021	Unocc Mode Testing - 50% of 5th floor
TU	31-Oct-2021	Unocc Mode Testing - 50% of 5th floor
TU	30-Oct-2021	Unocc Mode Testing - 50% of 1st/2nd floors
TU	29-Oct-2021	Unocc Mode Testing - 50% of 1st/2nd floors
TU	28-Oct-2021	Unocc Mode Testing - 50% of 3rd/4th floors
TU	27-Oct-2021	Unocc Mode Testing - 50% of 3rd/4th floors
TU	25-Sep-2021	Occ Mode Testing - All Floors

Equip Name	Test Date	Start Time	End Time	# Pass	# Fail	Notes	Download PDF Report	Download Excel Report	Detail Tile View
TU1_00	29-Oct-2021	12:00AM	4:40AM	16	1		Download PDF	Download Excel	Tile View
TU1_01	29-Oct-2021	12:00AM	4:40AM	12	5		Download PDF	Download Excel	Tile View
TU1_02	29-Oct-2021	12:00AM	4:40AM	17	0		Download PDF	Download Excel	Tile View
TU2_01	29-Oct-2021	12:00AM	4:40AM	16	1		Download PDF	Download Excel	Tile View
TU2_02	29-Oct-2021	12:00AM	4:40AM	14	3		Download PDF	Download Excel	Tile View
TU2_03	29-Oct-2021	12:00AM	4:40AM	16	1		Download PDF	Download Excel	Tile View
TU2_04	29-Oct-2021	12:00AM	4:40AM	15	2		Download PDF	Download Excel	Tile View
TU2_05	29-Oct-2021	12:00AM	4:40AM	15	2		Download PDF	Download Excel	Tile View
TU2_06	29-Oct-2021	12:00AM	4:40AM	15	2		Download PDF	Download Excel	Tile View
TU2_07	29-Oct-2021	12:00AM	4:40AM	15	2		Download PDF	Download Excel	Tile View
TU2_08	29-Oct-2021	12:00AM	4:40AM	17	0		Download PDF	Download Excel	Tile View

Figure 3. OTTO Summary Test View for KSU Academic Learning Center

In conclusion, technology advances plus standardization initiatives like Project Haystack have enabled commissioning providers to be more efficient with their time while maintaining a high level of service plus additional benefits to their clients. We have embraced automated functional testing as a result and will look to expand its use over time.

Darren Draper, PE, CxA, LEED AP, of the Epsten Group has 16 years of experience in the building services industry. He serves as commissioning agent on a wide range of facilities including university buildings, research laboratories, healthcare facilities, and data centers.

Project Haystack's Role in ESG

LYNXSPRING®

"While adopting ESG principles and creating outcomes from it have become important, implementing a successful ESG program is one of the most complex challenges we are dealing with in making our buildings smarter."

Adopting Environmental. Social. Governance. (ESG) principals has become more pressing today with many building owners and operators making it a priority to invest resources in this effort.

This acceleration is being driven by the heightened attention within the C-Suite on the broader impact ESG has on companies, as well as by investors and executives who realize that a strong ESG proposition can safeguard a company's long-term success. In fact, according to a recent survey by Grant Thornton LLP, 70% of CFO's responded saying ESG is a top consideration in their companies. Furthermore, this survey indicated that ESG investments are much more important to their organization than they were prior to 2020.

While adopting ESG principles and creating outcomes from it have become important, implementing a successful ESG program is one of the most complex challenges we are dealing with in making our buildings smarter.

ESG is not an endpoint, but rather an endless pursuit to make our buildings smarter and responsible. From commitment to accountability; to data disclosure and transparency; to metrics; to standards and directives; one thing is for certain, there is a universal requirement for quality data identification, aggregation, and curation across the complex aspects of operational systems and equipment, health, safety concerns, the environment, and people. Quality, operationalized data leads to more accurate insights, improved decision-making, and better outcomes.

"Operationalized data can be a buildings most valuable asset. When captured, processed, normalized, tagged, and analyzed, it can enable a true transformation on how buildings are managed and operated."

Within ESG, effective use of data is a challenge for many. Organizations that use the right data to report on ESG factors gain critical competitive advantage by understanding and acting on the information. The challenge is to be able to aggregate data from diverse sources and normalize it in a standard format that enables understanding across multiple dimensions. Furthermore, reporting is central to measuring and understanding ESG performance data. An ESG program will require accurate, relevant, and data across the enterprise of systems, and a uniform approach to adding meta data is a key requirement.

So, what is Haystack's role in ESG?

DATA stewardship, transparency, alignment of definitions, interoperability, and simplification.

As a data modeling schema, Haystack's semantic modeling, ontology, tagging conventions contextualization, and taxonomies provide a consistent, standardized methodology for describing data and the systems producing it. Haystack enable true data interoperability---clearly defined data that can be shared across any system, equipment, application, or organizational boundary to advance the exchange, interpretation, use and value of it.

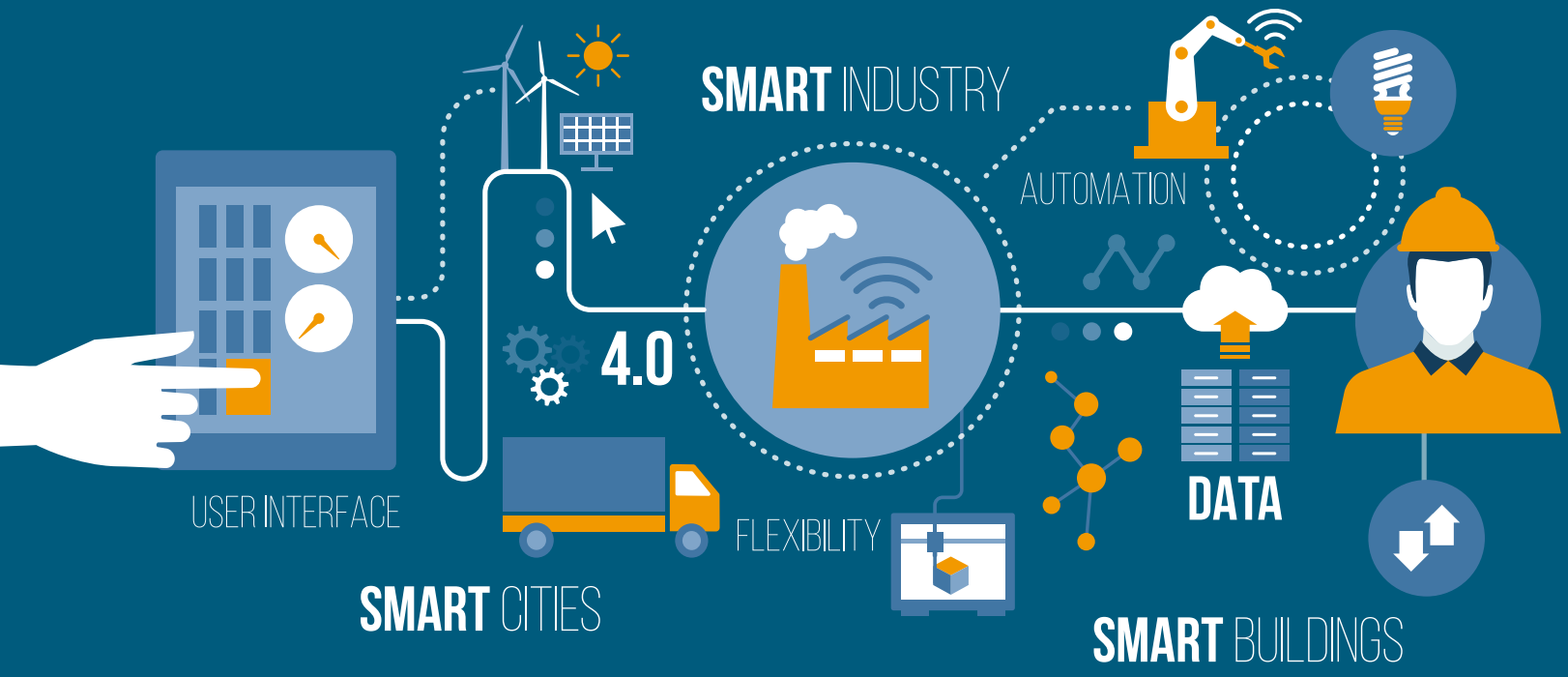
Haystack is an open, non-proprietary, proven, and widely accepted solution to the semantic modeling of building systems, which reduces complexity and removes the "data barrier challenge" by operationalizing data and enabling data clarity, quality, transparency, standardization, control, and uniformity across all building asset classes. It provides for a single, unified, consensus-based standard to address semantic interoperability of data from building systems.

As organizations develop and execute their ESG plans, it is critical to improve the way they identify, aggregate, and manage their operational data. While there is no single model for building an ESG program or single standard approach to the organization and use of data as each organization will have its own situations to consider, one thing is certain, the adoption and use of Project Haystack methodologies is a powerful catalyst to ensure a strong ESG proposition and data management foundation for delivering a successful ESG culture, strategy, insight, and outcomes that matter.

ESG is not a single issue, it is about how organizations operate, their resilience, leadership, flexibility, and corporate social responsibility toward our environment.

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.

Recap:
Haystack Connect 2021!



Haystack Connect 2021 is organized and produced biennially by the Project Haystack Organization.

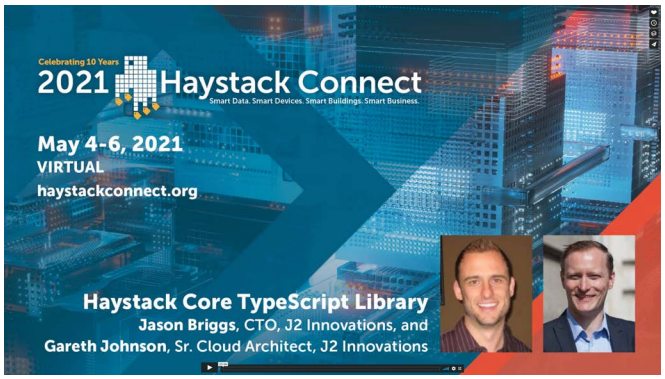
The event builds on the inspiration and mission of the community to address the challenges of making smart device data work seamlessly across applications of all types through the adoption of a standard approach to semantic modeling of equipment systems and their data.

This year marked the 10th Anniversary of the Project Haystack Organization's formation. To commemorate the occasion and allow the greatest number of people to attend, Project Haystack made registration for Haystack Connect 2021 FREE for all attendees.

And, for those who may have missed the conference back in May of 2021, all sessions and presentations were recorded and are available for viewing at https://www.haystackconnect.org/schedule.


Celebrating 10 Years
2021 Haystack Connect
Smart Data. Smart Devices. Smart Buildings. Smart Business.
May 4-6, 2021
VIRTUAL
haystackconnect.org
Developer's View of Haystack 4
Brian Frank, Technical Lead, Project Haystack


Celebrating 10 Years
2021 Haystack Connect
Smart Data. Smart Devices. Smart Buildings. Smart Business.
May 4-6, 2021
VIRTUAL
haystackconnect.org
Haystack as Part of the
Solution to Climate Change
Omar Tabba, Vice President, Products & Solutions, BrainBox AI


Celebrating 10 Years
2021 Haystack Connect
Smart Data. Smart Devices. Smart Buildings. Smart Business.
May 4-6, 2021
VIRTUAL
haystackconnect.org
Haystack Core TypeScript Library
Jason Briggs, CTO, J2 Innovations, and
Gareth Johnson, Sr. Cloud Architect, J2 Innovations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haystackconnect.org
Ontology Alignment Project
Jon Schoenfeld, Director of Energy and Analytics, Buildings IOT


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May 4-6, 2021
VIRTUAL
haystackconnect.org
Haxall – A New Haystack
Open Source Framework
Brian Frank, CEO and Founder, SkyFoundry


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2021 Haystack Connect
Smart Data. Smart Devices. Smart Buildings. Smart Business.
May 4-6, 2021
VIRTUAL
haystackconnect.org
Dynamic Integration in Digital Twins
Anto Budiardjo, CEO, Padi, Inc.


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May 4-6, 2021
VIRTUAL
haystackconnect.org
Haystack in Practice –
Success Story for Coster Group
Alex Rohweder, CEO, J2 Innovations; Matteo Pierone,
Global Strategy Head & EMEA Professional Services Director,
J2 Innovations; Davide Manca, R&D Manager, Coster Group;
and Fabio Antoci, R&D Engineer, Coster Group


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May 4-6, 2021
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haystackconnect.org
Haystack in TwinWorX Digital Twins Solution
Eugene Woo, Chief Technology Officer, e-Magic Inc.


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May 4-6, 2021
VIRTUAL
haystackconnect.org
Applying Haystack Tagging to Variable Refrigeration Systems
Yuya Saito, Associate, Innovation Program, Daikin Open Innovation Lab Silicon Valley (DSV)


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May 4-6, 2021
VIRTUAL
haystackconnect.org
Applying Haystack 4 in a Residential Analytics and Control Application
Adam Wallen, Training Lead, SkyFoundry


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Smart Data. Smart Devices. Smart Buildings. Smart Business.
May 4-6, 2021
VIRTUAL
haystackconnect.org
WG#798 Haystack JSON Encoding
Gareth Johnson, Senior Cloud Architect, J2 Innovations, and Radu Racariu, Senior Programmer, J2 Innovations


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May 4-6, 2021
VIRTUAL
haystackconnect.org
Haystack Benefits in the K-12 Education Market
Jamie Lee, Product Manager, Siemens Industry, Inc, and Steve Crowe, Integration Team Project Manager, Resolute Building Intelligence


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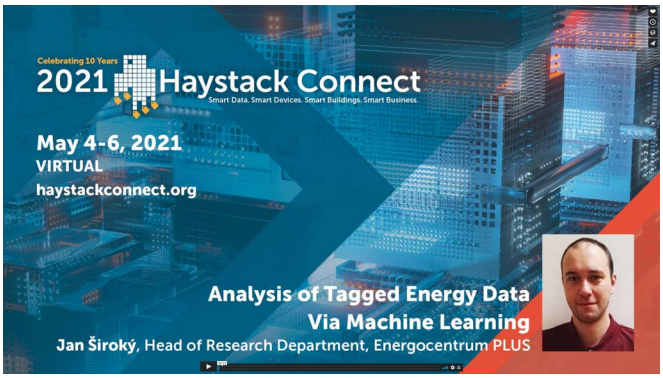
May 4-6, 2021
VIRTUAL
haystackconnect.org
Haystack Labs: Prototyping Data Validation with Functional Point Groups and SHACL
Cory Mosiman, Software Engineer, PassiveLogic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haystackconnect.org
Analysis of Tagged Energy Data Via Machine Learning
Jan Široký, Head of Research Department, Energocentrum PLUS


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May 4-6, 2021
VIRTUAL
haystackconnect.org
PITCHFEST
Emma Eynon, Director, Fantom Factory
Anto Budiardjo, CEO, Padi, Inc.
Philippe Prados, Data Scientist/Architect, Engie Digital & OCTO Technology
Scott Muench, Vice President of Customer Experience, J2 Innovations
Jeremy Wolfe, Vice President Sales Americas, J2 Innovations
Jean-Simon Venne, Co-Founder and CTO, BrainBox AI
Shilpa Basappa, Associate Director of Engineering, 75F
Alper Üzmezler, Managing Partner, BAS Services & Graphics, LLC


Celebrating 10 Years
2021 Haystack Connect
Smart Data. Smart Devices. Smart Buildings. Smart Business.
May 4-6, 2021
VIRTUAL
haystackconnect.org
Tridium's Haystack Tag Dictionary
Eric Anderson, Niagara Software Engineer, Tridium

Past Conference Websites

Haystack Connect 2013

Haystack Connect 2015

Haystack Connect 2017

Haystack Connect 2019

Haystack Connect 2021

Member Profile

The Newest Associate Member Companies Joining the Mission

75F designs and manufactures the world's leading IoT Building Management System (BMS), an out-of-the-box, vertically-integrated solution that is more affordable and easier to deploy than anything on the market today. The company leverages IoT, Cloud Computing, Machine Learning, and software-enabled hardware to predict, analyze, monitor, and control building HVAC equipment for comfort and air quality, all with energy savings of 30-50%.

Components in a typical 75F install include smart sensors that connect to the cloud for analysis, a 75F Central Control Unit as a supervisor with built-in wall interface, 75F Smart Nodes as terminal equipment controllers, 75F Dampers, and Facilisight, 75F's building intelligence suite of web and mobile apps for secure remote monitoring and control.

75F has a strong IP portfolio with custom hardware and proprietary cloud-based machine learning algorithms built on industry open source and open standards. All hardware is Haystack-native and ASHRAE GPC 36 compliant for advanced sequences for HVAC operations, both industry firsts.

You can learn more about us at 75f.io.

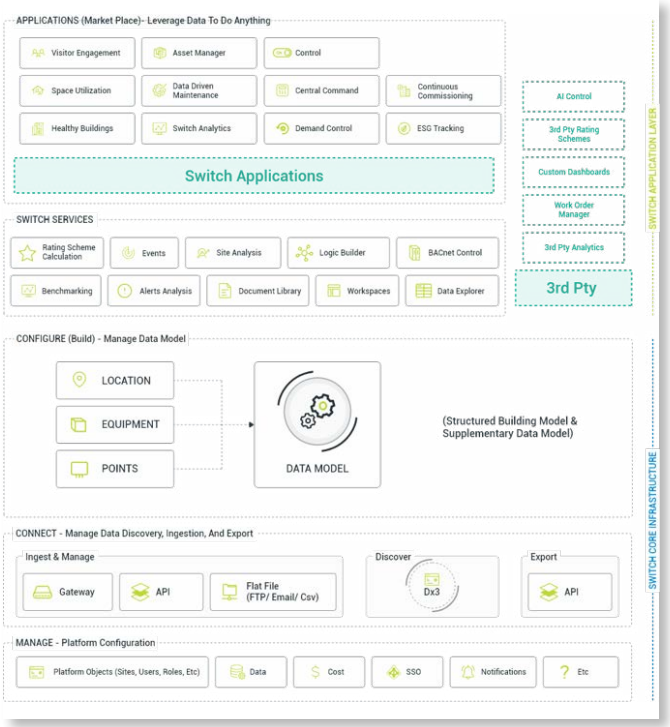
The Newest Associate Member Companies Joining the Mission

SWITCH AUTOMATION

Technology and big data are transforming the way the world lives, works and plays. But building management hasn't changed; it's still riddled with archaic spreadsheets, inaccessible data, clunky architecture and silos. It's time to improve the way we manage buildings.

Switch Automation is leading that charge. Our smart building Platform combines deep insight and robust tools that help you monitor, benchmark and optimize building performance.

The real beauty of the Platform is in its flexibility. The Switch Platform can be configured to match the needs of your business. Begin with one building or your entire portfolio. Employ fault detection, real-time control and much more. Start your smart building journey – and discover how proactive building management can positively impact your business.



Switch Automation is a global real estate software company that helps property owners and facility managers reduce operating costs, improve energy efficiency and deliver exceptional occupant satisfaction. Our comprehensive smart building platform integrates with traditional building systems as well as Internet of Things (IoT) technologies to analyze, automate and control assets in real-time. We serve enterprise customers and partners in a variety of industries including financial services, retail, grocery, commercial real estate and more.

Learn how Switch Automation creates technology to bring people and planet to the center of building operations at **switchautomation.com**.

Demand for Project Haystack participation is up at events around the world and community members have risen to the call.

AHR Expo 2022

The Role of Data in Achieving Smarter Buildings: Making Data Interoperable with Haystack

John Petze, Executive Director and Marc Petock, Executive Secretary of Project Haystack discuss the use of semantic tagging and its key role in data interoperability across different systems and applications. Determining what data is relevant, how to standardize and streamline it to unlock the data's true value, and how it enables a true transformation on the way we manage and operate buildings. The presentation will also provide an update on the latest work of the Project Haystack organization. Visit https://ahr22.mapyourshow.com/8_0/sessions/session-details.cfm?scheduleid=224 for more information.

PRESENTED BY: AutomatedBuildings.com.

CxEnergy 2022

APRIL 19-22
ORLANDO, FLORIDA

Project Haystack is proud to be a Supporter of the 2022 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.

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!

#734

ATES Systems WG

Champion: Jaap Balvers, BAM Building Analytics – BAM Energy Systems

As of **Haystack v.3.9.10**, the ATES definitions are included in the standard and available for all to use. The most common types of ATES systems are included. The status of the WG is now 'closed' but we are always welcoming input from the community to add to and improve the definitions.

https://project-haystack.org/forum/topic/734

#776

Greenhouse Gas WG

Champion: Ross Schwalm, SkyFoundry

The Greenhouse Gas WG (#776) submitted a proposal for adding greenhouse gases to the Haystack 4 ontology. The WG made the determination that the fundamental taxonomy was missing the concept of measuring emissions of specific types of gases. To solve that, the ^emission quantity was added that can be paired with a type of ^gas to track emissions of that type of gas into the atmosphere.

Some changes to the current taxonomy were made as well because the ^co and ^co2 defs were quantities instead of types of gases and were subtypes of ^airQuality which focused on measuring indoor air quality. The new ^concentration quantity was added, which slightly changes the way indoor air quality sensors are modeled.

If you are interested in more details or wish to contribute feedback, visit forum post **https://project-haystack.org/forum/topic/776**.

#837 Haystack Labs Standing WG

Champion:
Matthew Steen,
NREL

The Haystack Labs WG (837) continues to explore new directions for Project Haystack by identifying, prioritizing, and developing future needs of the community. In the past half year, the working group has identified the following concepts to explore as possible future proposals to the larger community.

1. Attributes
2. Protos
3. Loops and Systems
4. Portfolios

To date, one of these has been proposed. The **Attributes Proposal (957)** describes a way of storing metadata that changes infrequently such as design and rated values associated with equipment (i.e., non-telemetry data). The Protos work has focused on cleaning up the existing ones by identifying patterns that can be incorporated into the way they're currently autogenerated to eliminate non-sensical combinations (e.g., outside-duct-equip). Future work will focus on adding Protos that are currently missing as a first step towards possible validation of Haystack implementations. The Labs WG will be coordinating closely with the Project Haystack team working on the funded **Department of Energy's BENEFIT project**, which will create a validation and accreditation framework for semantic metadata models. The Loops and Systems concept that we're working on seeks to define loops (e.g., chilled water loop), plants (e.g. chilled water plant), and systems (e.g. variable refrigerant flow system) to allow users to more clearly describe these concepts in practice. Finally, the Portfolio concept seeks to provide users with a way to define a collection of distinct sites, which could be a single campus of buildings or a national portfolio of geographically distinct campuses.

If any of these concepts interest you or if you have other ideas about the future direction of Project Haystack, please consider joining the Haystack Labs WG.

Check out the Working Group here: **https://project-haystack.org/forum/topic/837**

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	Ross Schwalm
#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	Matthew Steen

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

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 White Paper 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 Specifications. Now available in English, French, Chinese, Japanese and Turkish.

Download — CABA White Paper that outlines how to use Haystack tagging in applications related to buildings, energy, and facility management.

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.

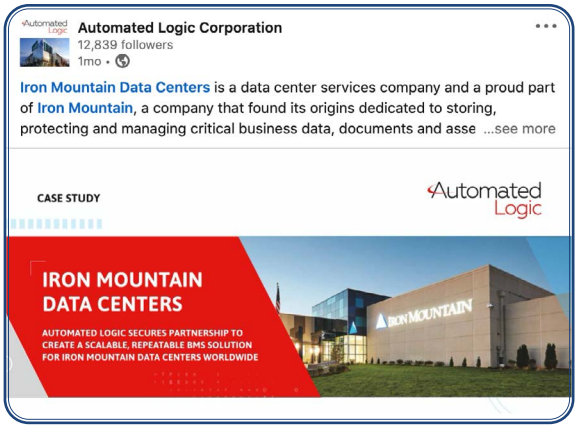
Social Media Curation

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

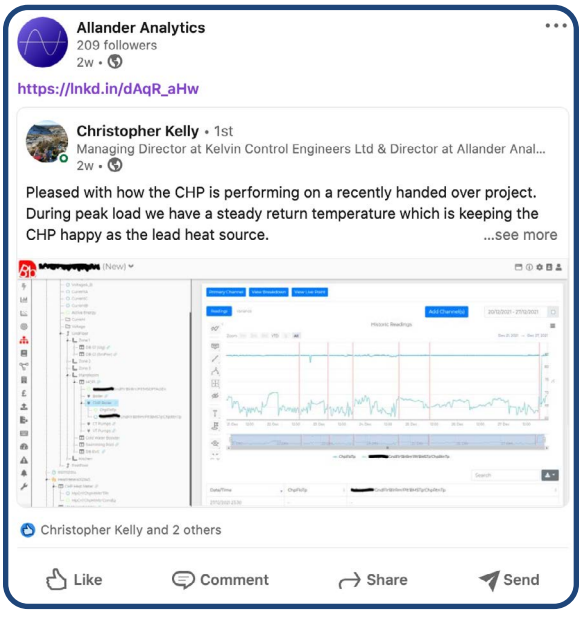
Projects

Helping to prevent Covid-19 in schools and save on building costs.

Industrial Oven Recipes Breakdown

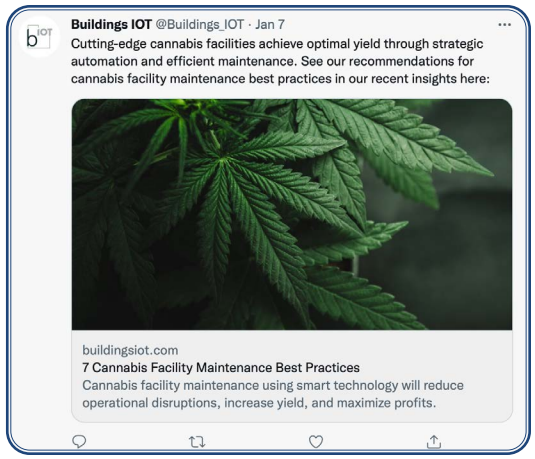


Creating a scalable, repeatable BMS solution.



Keeping the CHP happy as the lead heat source..

Practices

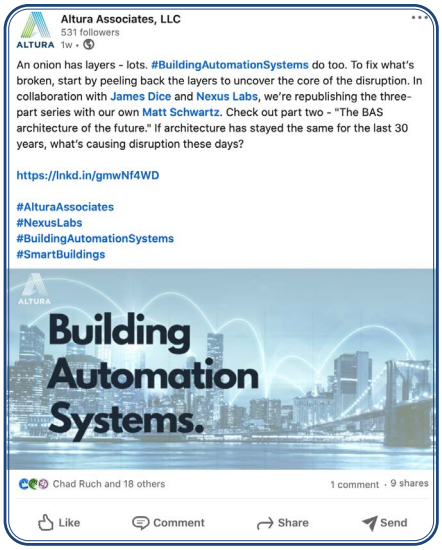


Achieving optimal yield through strategic automation and maintenance.

Driving the cybersecurity issues in the industry through volunteer efforts.

Let's Talk About Renewable Energy!

Smart Women, Smarter Buildings!

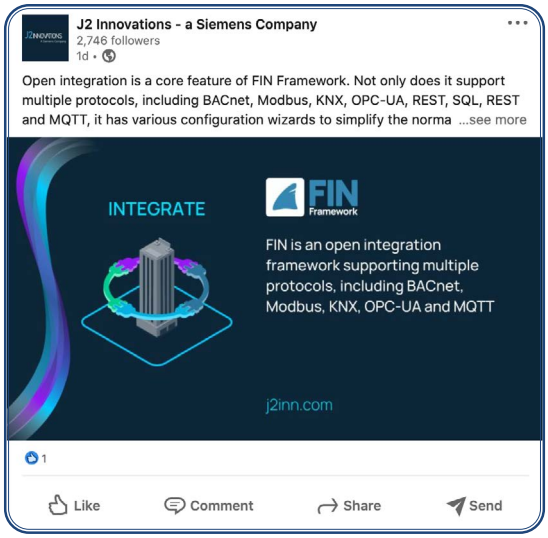


Peeling back the layers of BAS to fix what's broken.

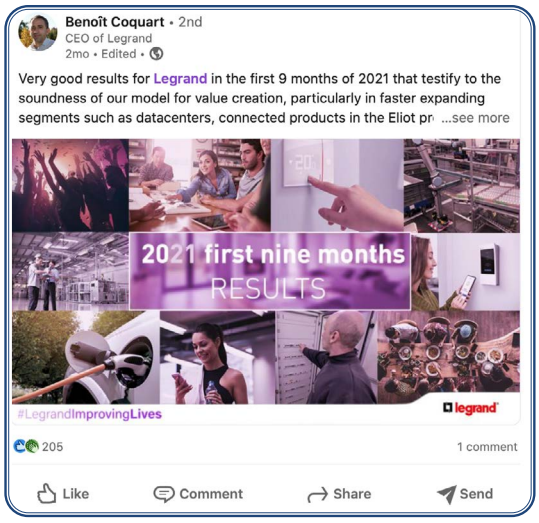
Products

Free online CTRLSpecBuilder specification tool for creating specs for HVAC control systems.

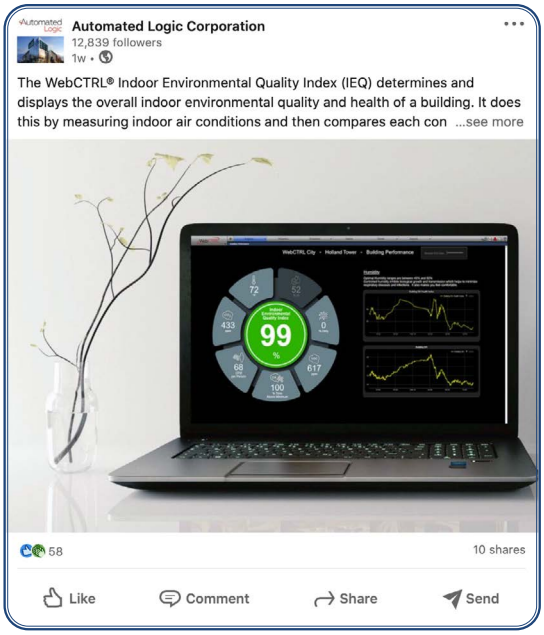
PlantPro and IC-Edge-X1 Controller, for aggregating all types of building data.



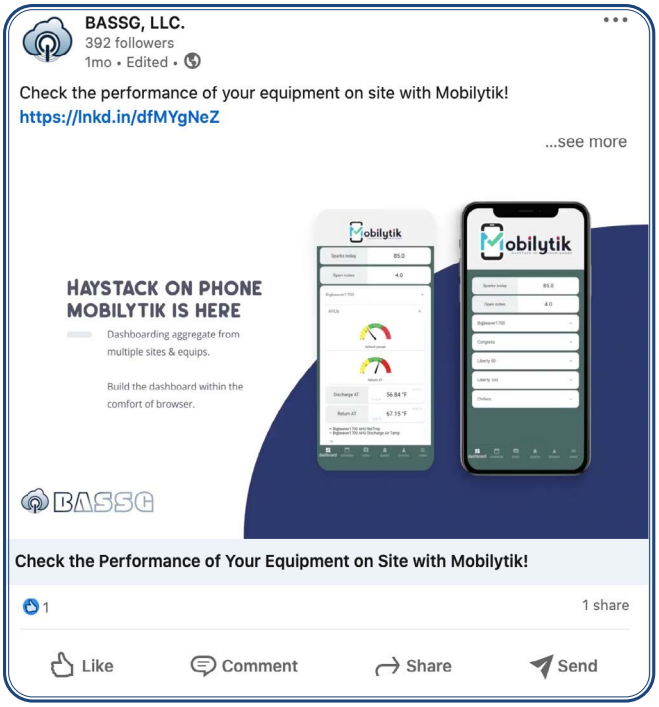
Open integration is a core feature of the FIN Framework.



Creating value in expanding market segments like data centers.

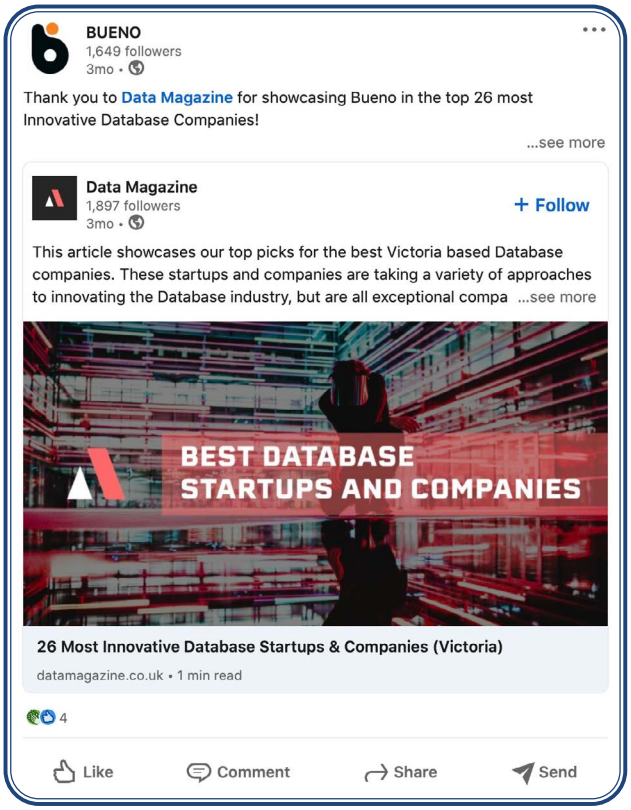


Introducing the WebCTRL Indoor Environmental Quality Index (IEQ)



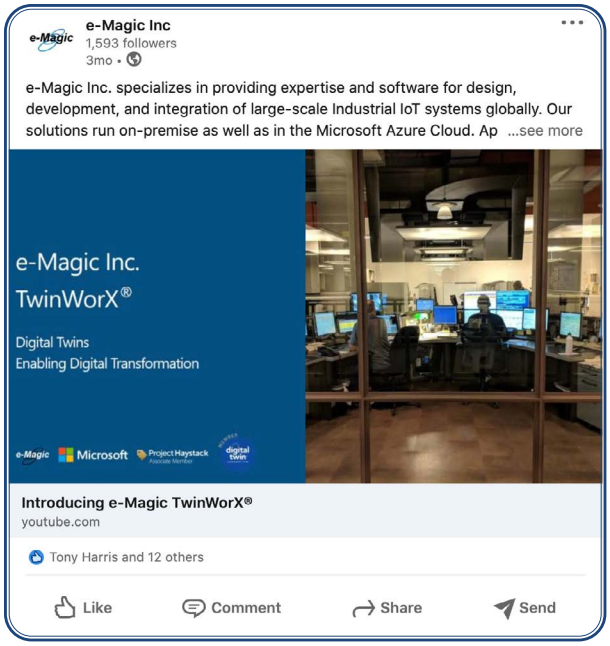
Haystack on your phone. Mobilytik by BASSG.

An official Niagara Framework developer.



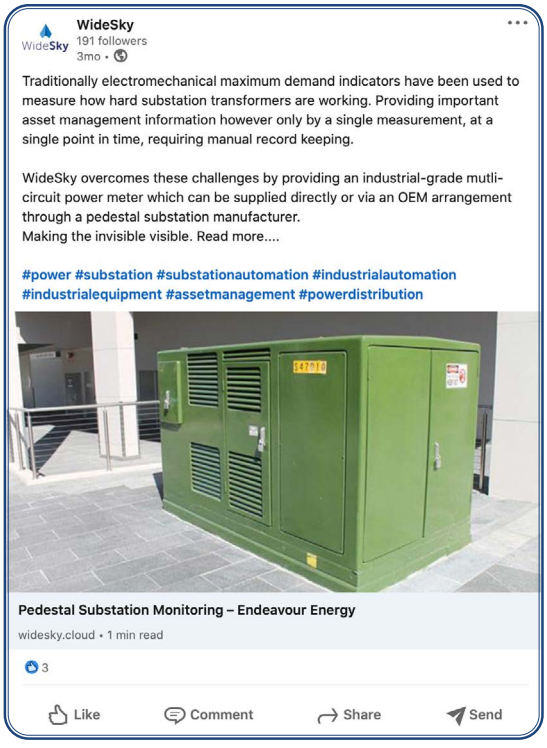
Bueno showcased in the top 26 most innovative Database companies.

Products

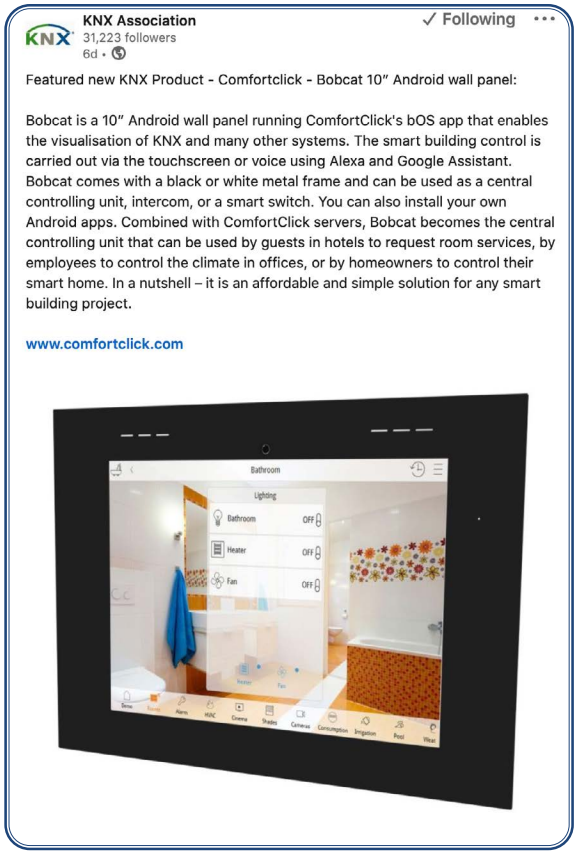


Introducing e-Magic TwinWorX

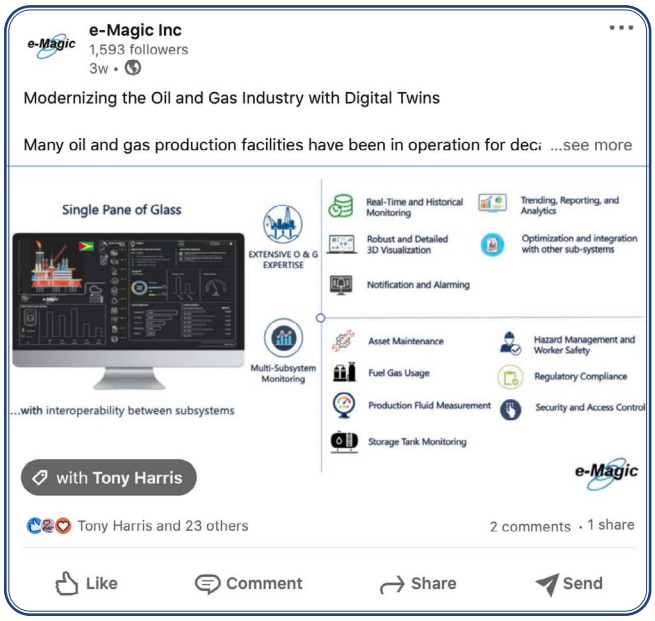
Optimizing building efficiencies evolves into unique educational opportunity for school students.



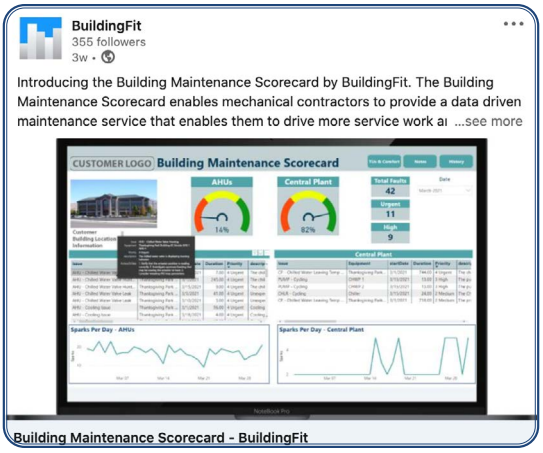
Industrial-Grade Multi-Circuit Power Meter



Comfortclick bOS app running on a Bobcat 10" Android Wall Panel.



Modernizing the Oil & Gas Industry



Introducing a Building Maintenance Scorecard

IoT Platforms Leadership Award

Ad Directory

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 are creators of FIN Framework, a next-generation software framework for smart buildings, smart equipment and IoT applications. Natively based on Haystack tagging, FIN can integrate, control, manage, analyze, visualize, connect, and can be embedded on a controller, gateway, HMI or server. FIN Framework offers OEMs, System Integrators, and end user solutions that are faster, easier, and better.

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

75F designs and manufactures the world's leading IoT Building Management System, an out-of-the-box, vertically-integrated solution that is more affordable and easier to deploy than anything on the market today. The company leverages IoT, Cloud Computing, and Machine Learning for data-driven, proactive building intelligence and controls for HVAC optimization. 75F's mission is to improve occupant productivity through enhanced comfort and indoor air quality — all while saving energy.

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.

Allander Analytics designs and develops industry-leading energy management and data visualization software. Our Building Book platform enables users to model, analyze and report on the energy consumption of their buildings. Using the latest technologies and the power of the cloud, we provide real-time analytics alerting customers to anomalies and opportunities within their data.

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.

Automated Logic is a global provider of high-performance, integrated building management solutions that make buildings smarter, more energy efficient, and more comfortable. Automated Logic's worldwide network of authorized partners includes over 230 field offices, with proven experience in building automation, energy management, and controls. It is also part of Carrier Global Corporation (NYSE: CARR), a leading global provider of healthy, safe, and sustainable building and cold chain solutions.

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.

Associate Members

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.

At Buildings IOT, we're changing the way the built environment understands, reacts and adapts through technology. Our software and services increase the longevity of building assets, improve the comfort of building occupants and help building owners achieve greater efficiency. We develop and deploy cloud-based building analytics software, we implement complex Integrated Building Management Systems, we design and install controls systems, we maintain building assets and we provide IT managed services. We excel at all of our efforts because we know buildings.

The Clockworks Analytics HVAC Fault Detection and Diagnostics (FDD) platform plugs into existing BMS and metering systems and analyzes thousands of data points to prioritize the building issues related to energy performance, indoor air quality and equipment operation. Our unique information model goes beyond simple fault detection by identifying the relationships between issues, diagnosing the root cause, and providing clear recommended actions. Clockworks' analytics-based monitoring allows you to proactively address building health issues, save energy and avoid reactive failures tomorrow.

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.

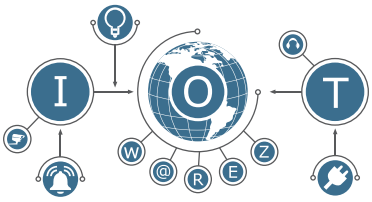
e-Magic Inc. specializes in providing expertise and software for the design, development, and integration of large scale industrial IoT and Azure Digital Twins solutions globally Applications include Centralized Operations, Smart Buildings, Facilities and Cities, Smart Manufacturing, Industrial production 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.

Associate Members

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, 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.

Technology and big data are transforming the way the world lives, works and plays. But building management hasn't changed; it's still riddled with archaic spreadsheets, inaccessible data, clunky architecture and silos. It's time to improve the way we manage buildings. Switch Automation is leading that charge. Our smart building Platform combines deep insight and robust tools that help you monitor, benchmark and optimize building performance.

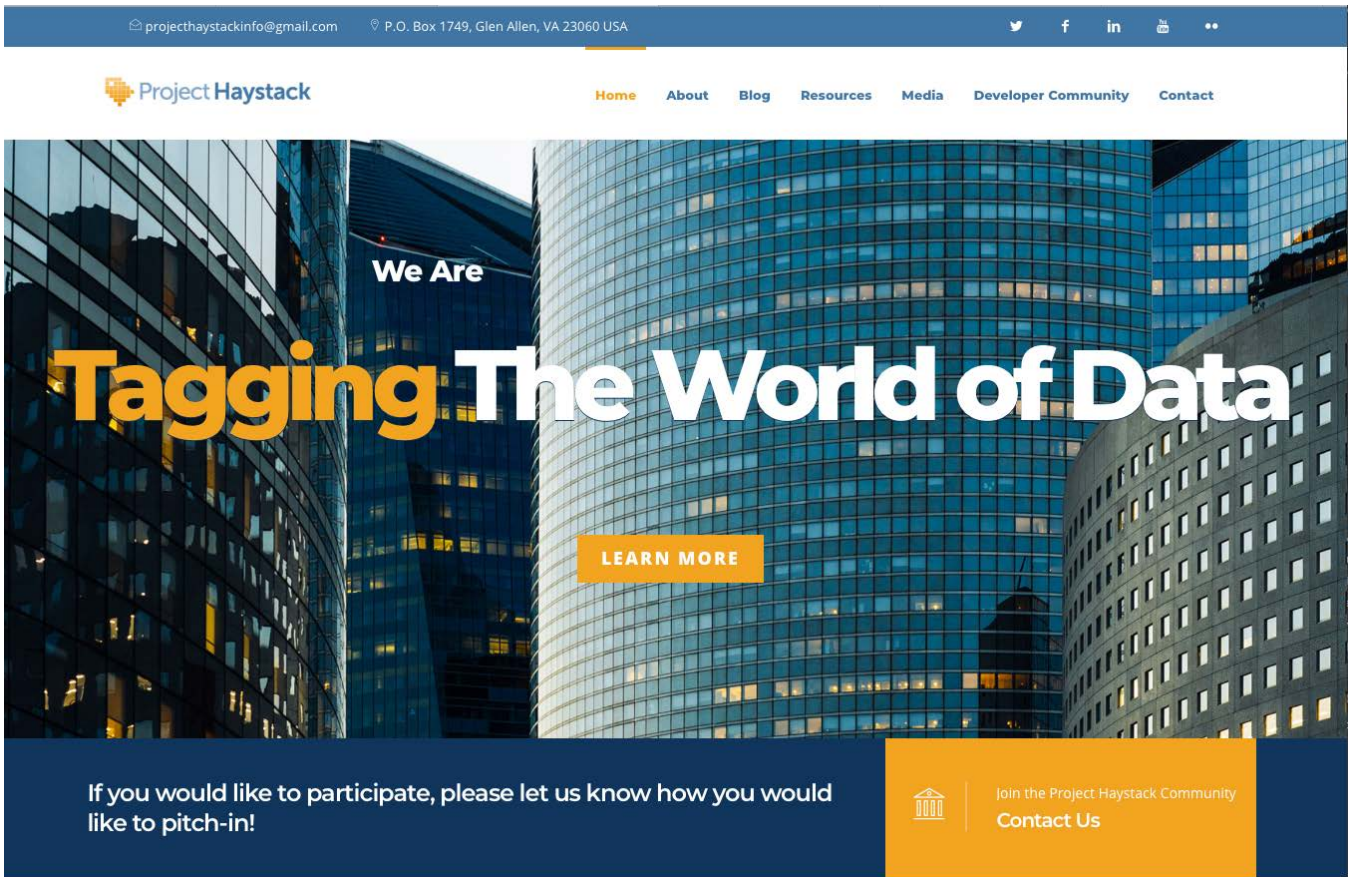
Tridium is a world leader in business application frameworks - advancing truly open environments that harness the power of the Internet of Things. Our innovations have fundamentally changed the way people connect and control devices and systems. Our products allow people and machines to communicate and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

Associate Members

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.

For all the latest Project Haystack marketing activities visit marketing.project-haystack.org.



Project Haystack

www.project-haystack.org