



Stephen Lothrop
PAE



MODELS TO MEANING



Tristan de Frondeville
SkyCentrics



Kimon Onuma
ONUMA





Digital Twin
Labs

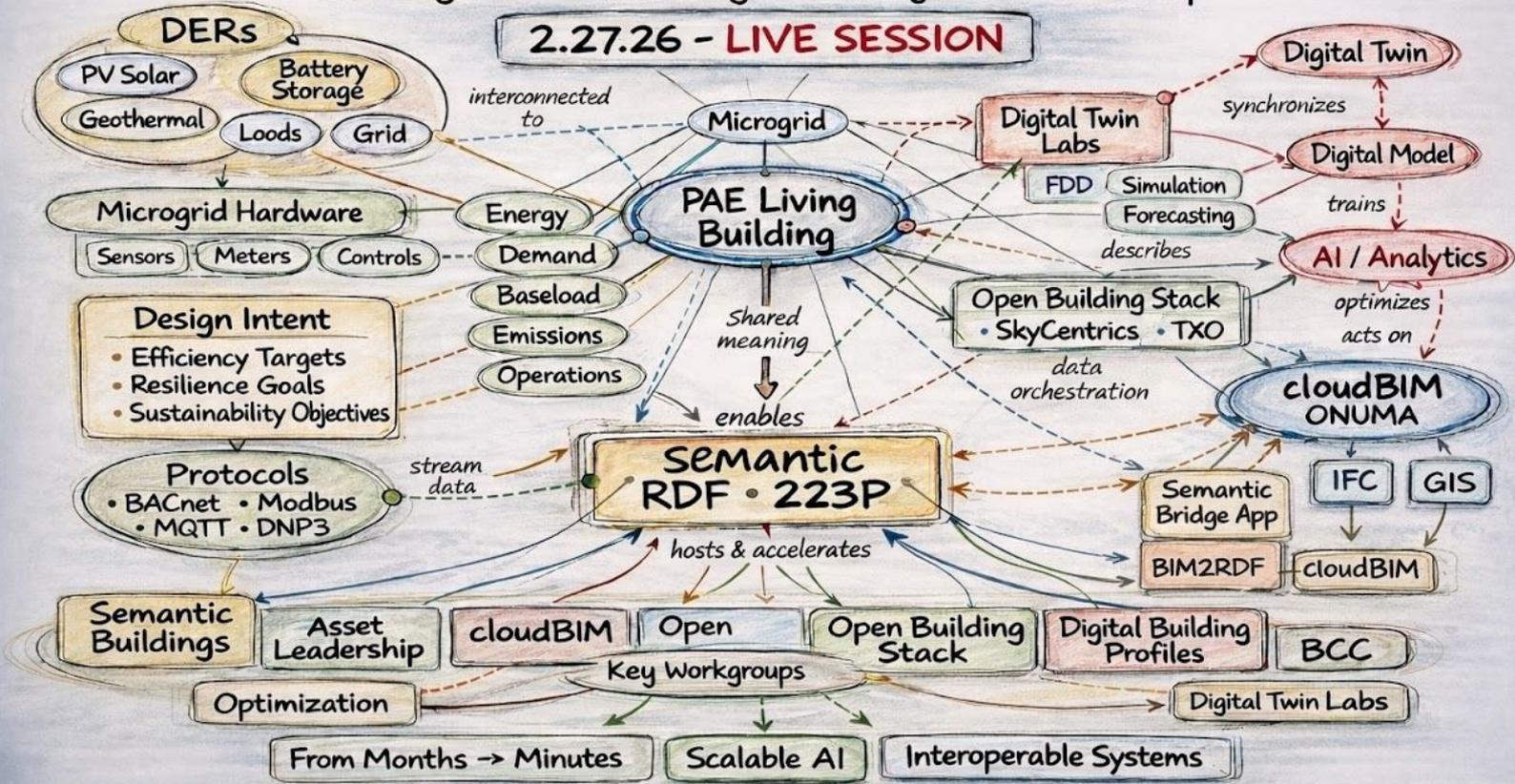
OPEN FDD Spec



MODELS TO MEANING

Building-Aware AI: Closing the Microgrid Semantic Gap

2.27.26 - LIVE SESSION





PAE Living Building

PORTLAND, OR | OPENED IN 2021



Developer-led Living Buildings are a possibility

WHAT WE LEARNED



To maintain tenant flexibility 20-25 EUI is ideal in Portland



Vacuum flush and composting toilets provides better control



60% of our PV-generation is on an array donated to an affordable housing development



Microgrids, batteries, resilience, and the grid



Net Zero Energy

58k

Square Feet



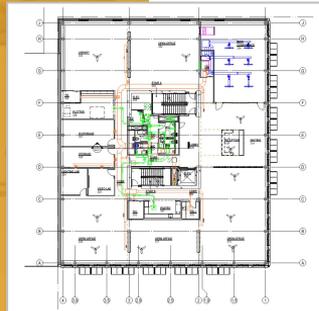
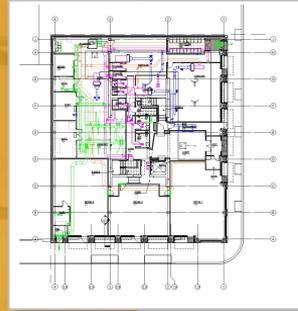
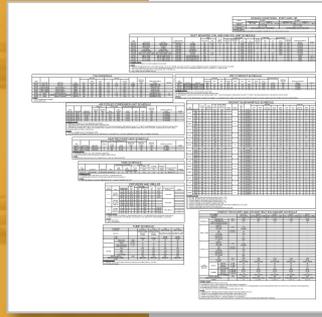
Net Zero Water

20

Energy Use Intensity

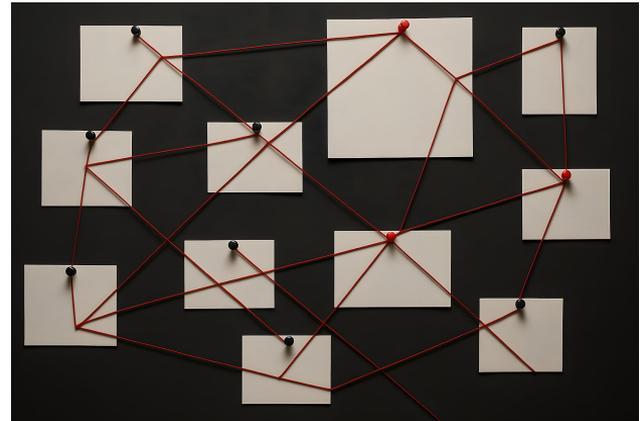
After Construction

Plans are put away “somewhere safe.” Figuring out how things are connected means opening a document and cross-referencing others. No way to see the connections from the collection.

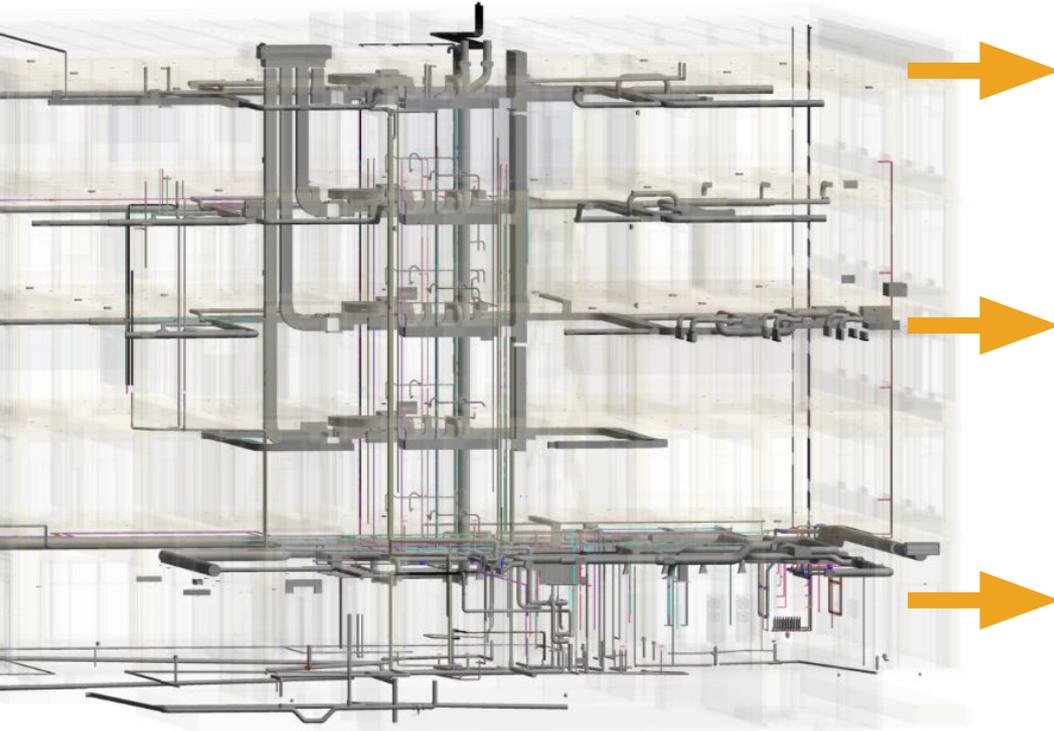


Relationships are not built into documents

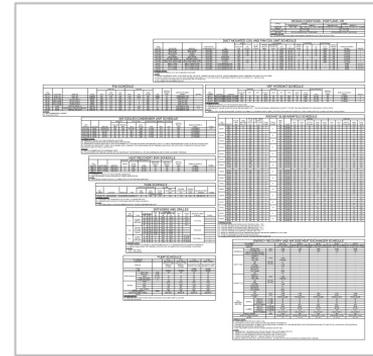
We create the meaning, connections, and relationships of data when we read it and cross-reference it. Computers don't have a way to infer meaning. They need to be told explicitly.



What do we do with the BIM?



Slice the building
into 2D slices to
put on PDFs

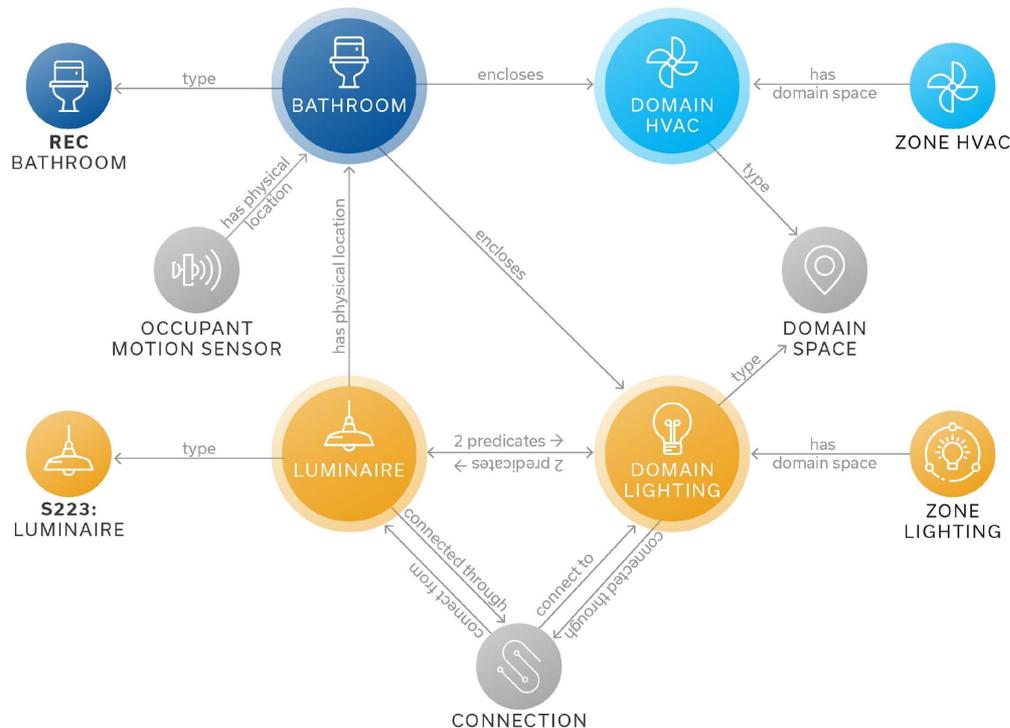


Create more
schedules



There are multiple ways to build a semantic model.
RDF semantic models can use multiple ontologies
simultaneously.

There is no need to choose just one

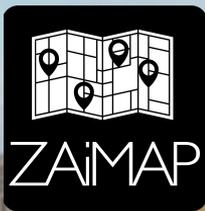


REC: Real Estate Core

<https://dev.realestatecore.io/ontology/Space/Architecture/Room/Bathroom>

s223: ASHRAE 223

<https://explore.open223.info/s223/Luminaire.html>



Kimon Onuma, FAIA
ONUMA, Inc.



INTENT TO LIFECYCLE

HANDOVER TO

CLOUD BIM
ARCHITECT



35 Years of Building Informed Environments



71 million square feet
2.75 million students
112 California locations



Architects, Engineers
Geodesigners, Analysts

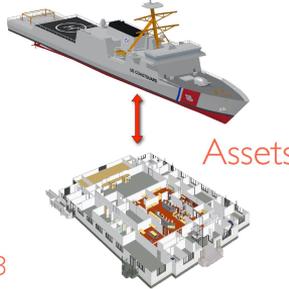


Yokosuka US Navy Base BIM



1994

US Coast Guard



2003

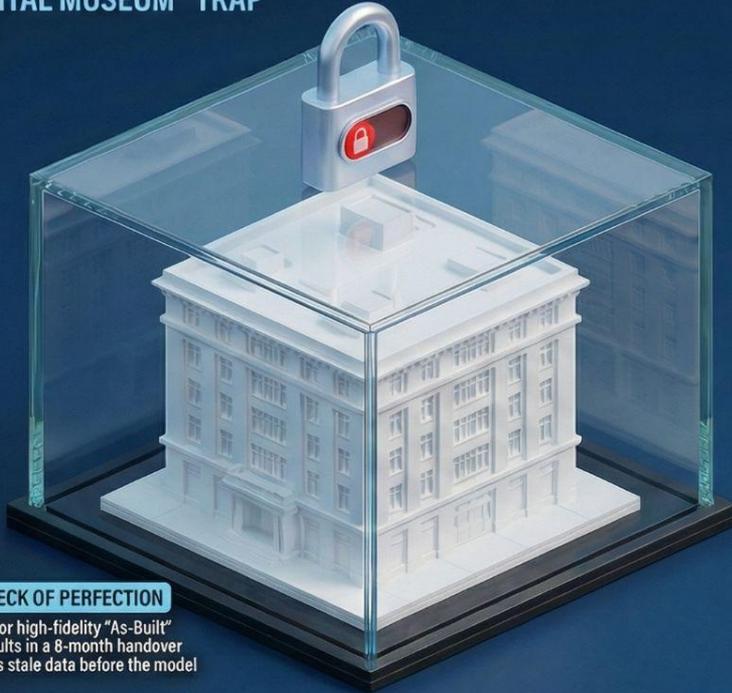


2024 Ellington Award:
Innovations in AI and Digital Ecosystems for Facility, Operations
at the Largest Community College District



CONNECTION BEFORE PERFECTION: THE MINIMUM VIABLE TWIN

THE “DIGITAL MUSEUM” TRAP (THE TRAP)



THE BOTTLENECK OF PERFECTION

Waiting months for high-fidelity “As-Built” Revit models results in a 8-month handover cycle that creates stale data before the model is even opened.

THE REALITY OF PROPRIETARY SILOS

Geometry is often locked in proprietary software, making it impossible to use for daily operations or cross-system integration.

“ A perfect map with no traffic data is useless. Without live connectivity, a high-detail model is merely a static asset with no operational utility. ”



THE “MINIMUM VIABLE TWIN” (THE SOLUTION)

START WITH WHAT YOU HAVE

Leverage existing “dirty” data, PDPs, Matterport scans, and simple massing to establish location and scale in under an hour.

CONNECTIVITY OVER COMPLEXITY

Use Web Service APIs (JSON/REST) to bridge the gap between static assets and live operations immediately.

MEANING VIA SEMANTICS

Contact and meaning emerge when simple assets are aligned to standards like ASHRAE 222P, allowing humans and AI to act on data.

CASE STUDY: NORTHGATE MARKET #39



LIVE CLOUDBIM ENVIRONMENT

FROM ZERO TO LIVE IN DAYS

Northgate integrated 140+ assets into a CloudBIM environment using live web APIs without waiting for perfect BIM standards.

DIRECT SYSTEM KNOWLEDGE WINS

Immediate value was achieved by identifying web service APIs instantly, gaining access to 50% of building data in minutes.

THE WINNING SEQUENCE

Operations first → Context second → Live integration third. Layer detail only as it becomes necessary for operations.

THE BOTTOM LINE

“DON'T WAIT FOR THE WALLS TO BE PERFECT TO TURN ON THE LIGHTS.”

CONTEXT > GEOMETRY: Meaningful operational intelligence is found in the connection between live flows and spatial context, not in geometric precision.

Velocity and access are the true drivers at digital transformation in the built environment.

A Platform is Infrastructure, Not an App

ASHRAE 2026 Seminar 42: From Models to Meaning: Bridging BIM, HVAC, and Operations with Ontologies



Definition: A platform is a shared infrastructure that makes building and portfolio data usable over time.

Clarification:

- ✓ It is **NOT** a BAS (Building Automation System).
- ✓ It is **NOT** a single building.
- ✓ It is **NOT** an app.

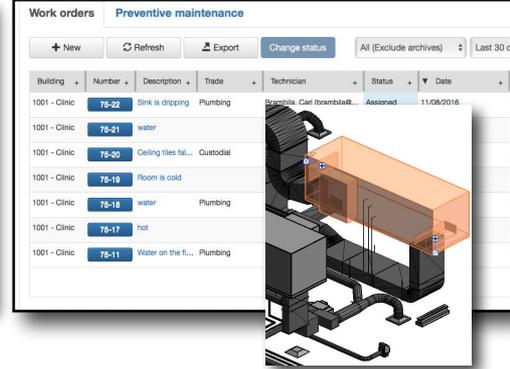
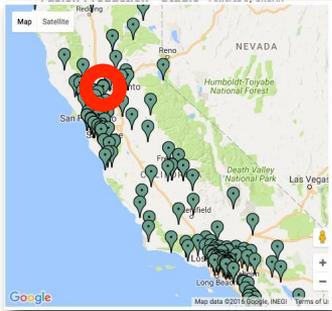
Role: Tools, devices, and software are just “containers.” The platform is what **keeps the data trustworthy, connected, and valuable** for many users (occupants, technicians, future teams).



California Community Colleges have the Data

Data translated into graphic floor plans

Largest College District in the US



Building	Number	Description	Trade	Technician	Status	Date
1001 - Clinic	75-22	Sink is dripping	Plumbing	Carl Ibrahimbl...	Assigned	11/08/2018
1001 - Clinic	75-21	water				
1001 - Clinic	75-20	Ceiling tiles fall...	Custodial			
1001 - Clinic	75-18	Room is cold				
1001 - Clinic	75-18	water	Plumbing			
1001 - Clinic	75-17	hot				
1001 - Clinic	75-11	Water on the fl...	Plumbing			

72 CCC Districts
~5,000 Buildings
~90M SF

LACCD GIS
9 Campuses
~18M SF

742 Building BIMs
30,599 Spaces
+75K Work Orders

6,600
Tagged Assets
In BIM

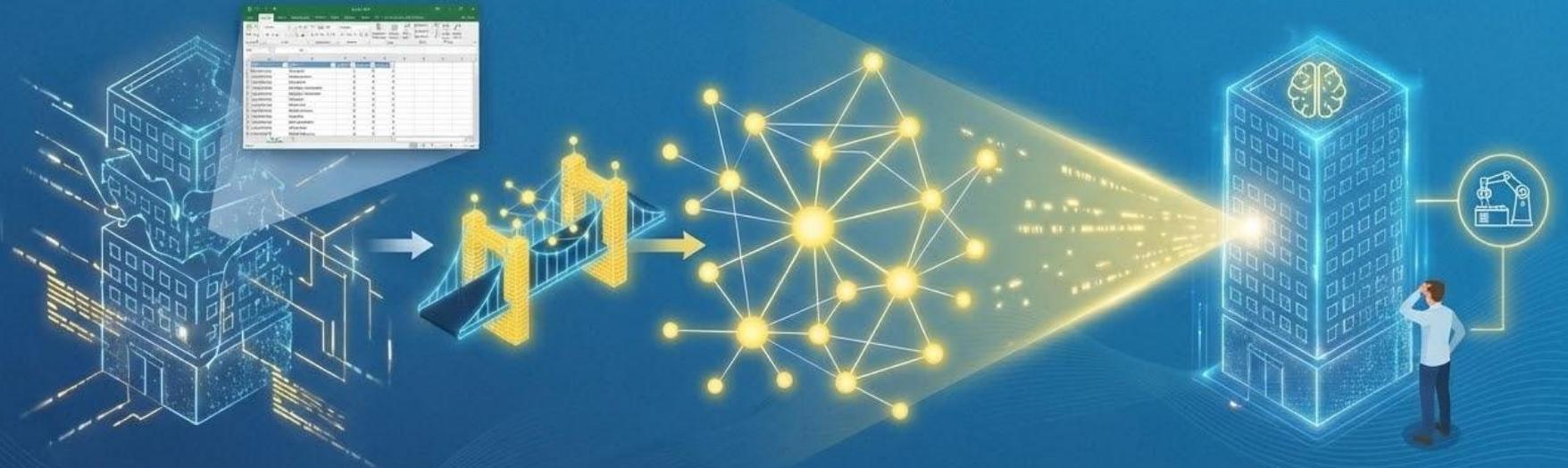
2011~2025 >

2021~2025 >

2021~2025 >

2024~2025 >

From BIM to Meaning: What a Semantic Model Does for Digital Twins and AI



BIM:

Isolated Parts & Data

RDF: The Semantic Model

(Meaning & Connections)

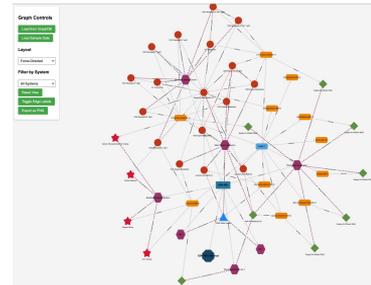
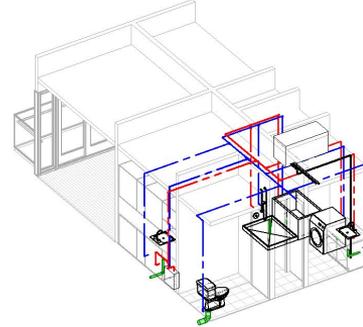
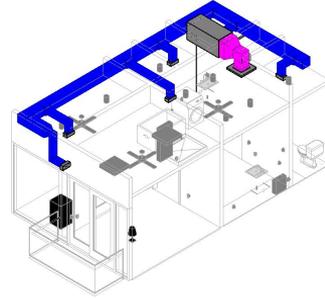
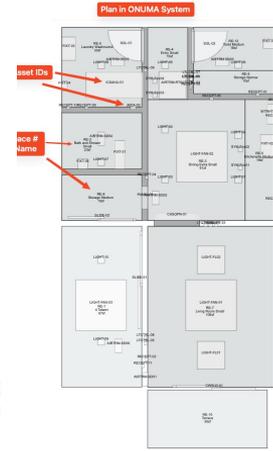
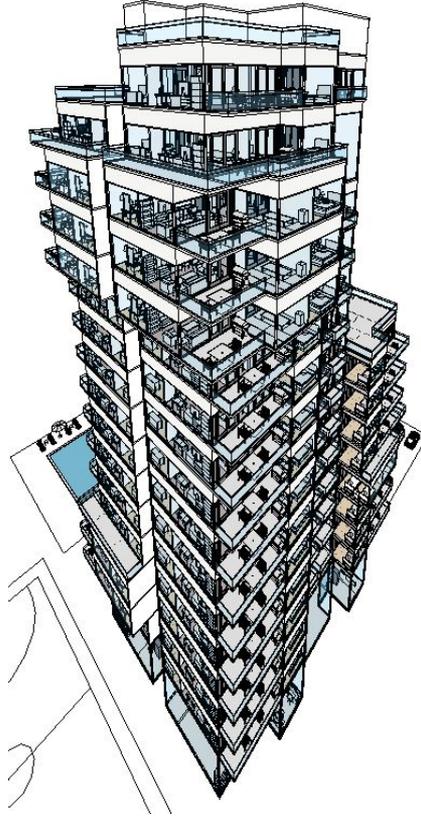
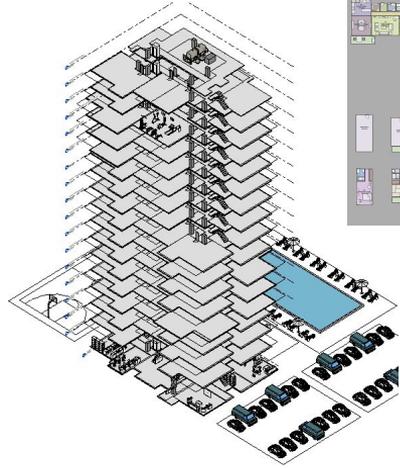
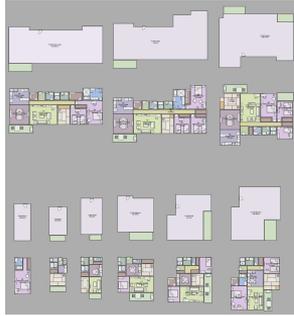
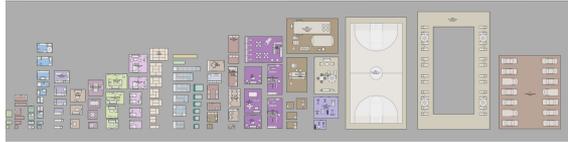
Digital Twin & AI:

Intelligent, Interconnected System

RDF is like a single-line diagram or an Excel table, it doesn't just list parts, it

shows the connections between them so machines and people can read the same logic.

From BIM to Meaning:



Monolith vs Microgrid: The Digital Twin Parallel

Hollywood BIM = Centralized Power Plant

- Massive
- Centralized
- High Maintenance
- Single Point of Failure
- Hard to Adapt



"It's impressive – but brittle."

Cloud BIM = Microgrid

- Distributed
- Modular
- Resilient
- API-connected
- Real-Time adaptable.



- Distributed. Modular. Adaptable.
- Designed for real-time conditions.

Operational resilience requires distributed intelligence —
not monolithic models.

ASHRAE Standard 223P

Title: Semantic Data Model for Analytics and Automation Applications in Buildings

Purpose: The purpose of this standard is to formally define knowledge concepts and a methodology to apply them to create interoperable, **machine-readable semantic models** for representing building system information for analytics, automation, and control.



BSR/ASHRAE Standard 223P

Public Review Draft

Semantic Data Model for Analytics and Automation Applications in Buildings

**First Publication Public Review (June 2025)
(Draft shows Proposed New Standard)**

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research-technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

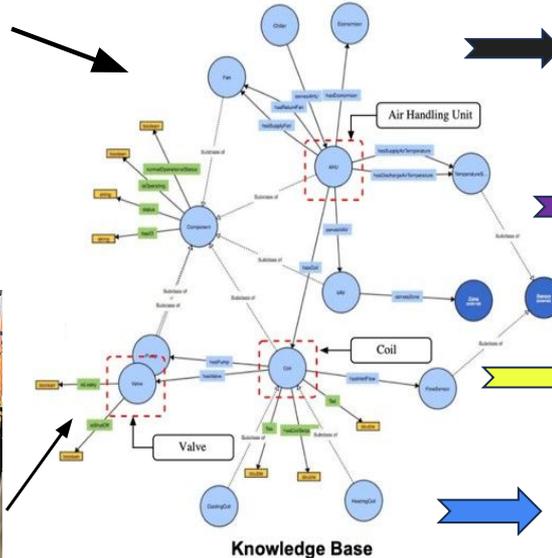
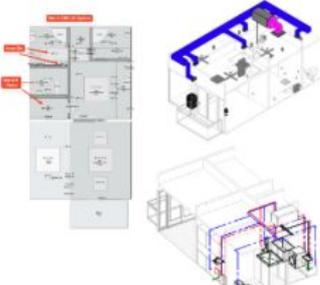
This standard is under continuous maintenance. To propose a change to the current standard, use the change submittal form available on the ASHRAE website, www.ashrae.org.

The appearance of any technical data or editorial material in this public review document does not constitute endorsement, warranty, or guaranty by ASHRAE of any product, service, process, procedure, or design, and ASHRAE expressly disclaims such.

Big Picture

❖ Semantic Graphs:

- Offer context to data acquired from various sources such as sensors, physical, and information models
- Enable applications to understand relationships and connections across data silos.



Building Digital Twin



Advanced Control



Fault Detection & Diagnostic

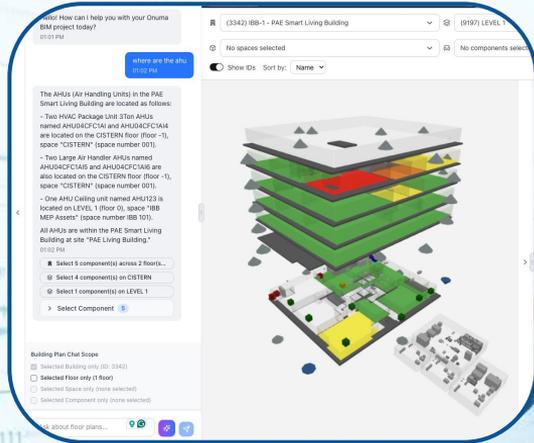


Auto Commissioning



4 - A Reference Implementation for Semantic Maintenance

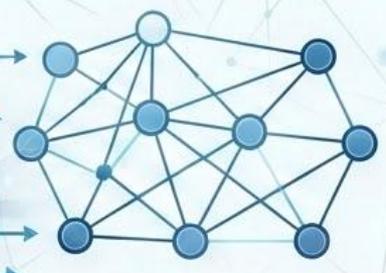
A live connection between operational cloudBIM and a Semantic Model Using ASHRAE 223.



**OPERATIONAL
cloudBIM**

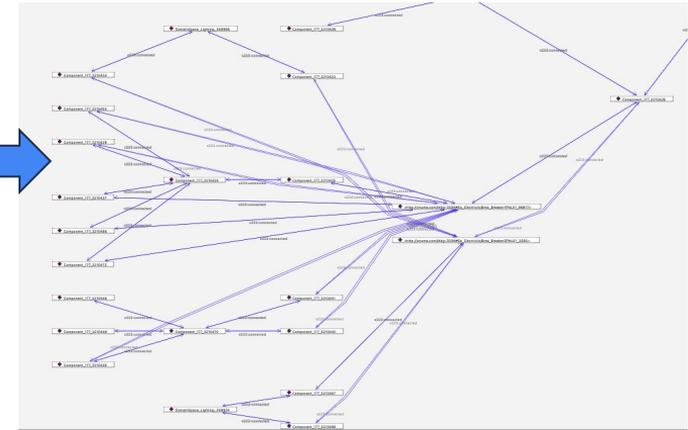
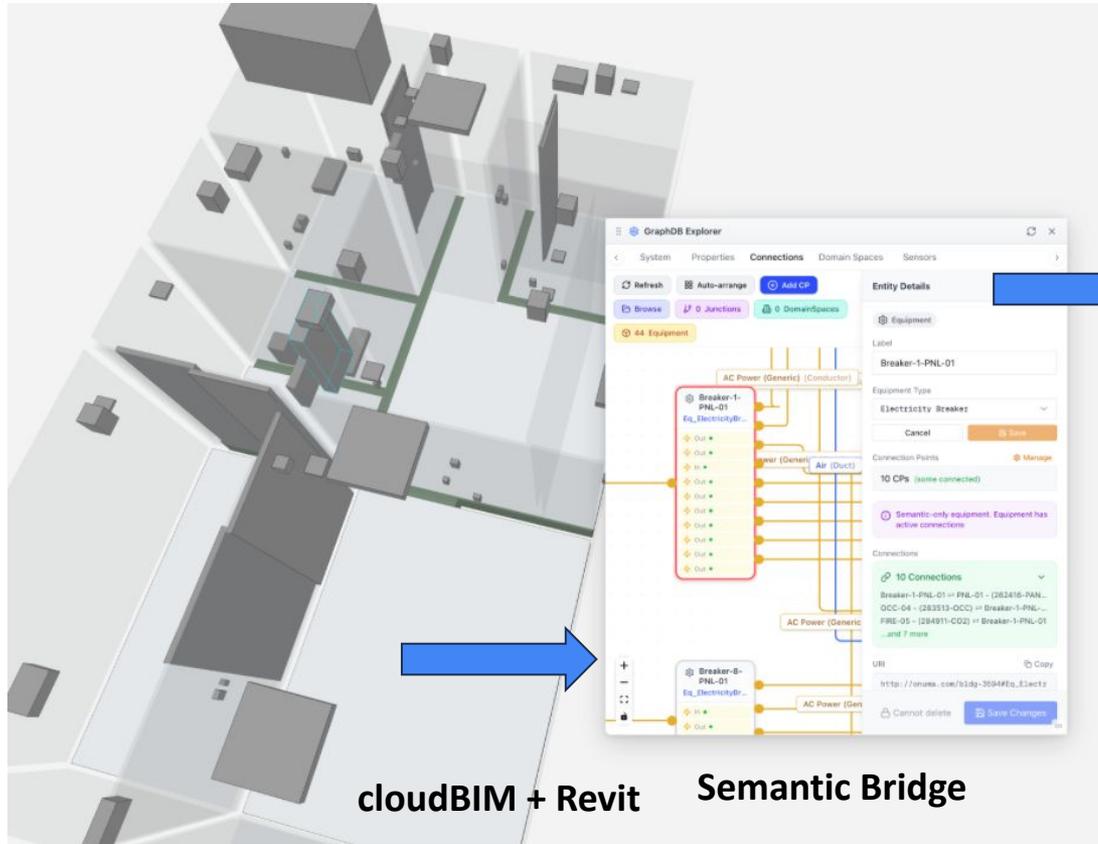


Semantic Bridge App
Two Way between BIM & RDF



**SEMANTIC
MODEL (RDF)**

A Potential Workflow to Create Semantic Graphs



ASHRAE223P graph (partial)

PAE Living Building and ONUMA Digital Twin

Space: 332 - OPEN OFFICE (314320)

General Summary Attributes Attachments Display Components

PAE Projects in the: **PAE Smart Living Building**

Space Monitoring: Temperature (F), CO2 (ppm), and Occupancy (24-hour view)

Previous Day **Oct 2, 2025** Room 332 Next Day

Space Environmental Conditions - Thursday, October 2, 2025 - Room 332

Temperature (F) CO2 (ppm)

— Temperature — CO2 — Occupancy — Dimmer %

Space Information

ONUMA 3D	View in 3D		
Tandem 3D	View in 3D		
Space Name	OPEN OFFICE	Space Capacity	0
Number	332	Space Occupancy	0
Area	1,128.0 sf	Space Capacity	0
Type	Office	Component Count	1

Views+Data Edit OFF Marquee (M) Print (P)



SkyCentrics

List Save and return to list Save

#3342-19171 (Assigned) BESS_STATE_OF_CHARGE (Battery Charge) is below 15%

Request Location Assignment Tasks Completion

PAE

IBB-1 - PAE Smart Living Building

LEVEL 1

126 - Main Electrical Room

optional

Attach component(s) from selected space

10 component selected (optional)

- 1543 | PAE - Generic Equipment | Standard
- 109 | PAE - Thermostat |
- 108 | PAE - Thermostat |
- 1016 | PAE - Ground Bar | Standard
- FCU-105 | PAE - Generic Mech Eqpm | PAE - Generic Mech Eqpm
- 85 | PAE - Panelboard | 1 - Surface - Standard

ONUMA.com

Label Style

Attachments Select files... Drop files here to upload



Search element

Search all

PAE Living Building

- IBB-1 - PAE Smart Living Building
 - T.O. PENTHOUSE
 - Roof
 - LEVEL 5
 - LEVEL 4
 - LEVEL 3
 - LEVEL 2
 - LEVEL 1A
 - LEVEL 1
 - 127 - Battery Room
 - 112 - BICYCLES
 - CHANGE
 - 109 - CHANGE
 - 124 - COMPOST
 - 119 - CORR
 - 130 - CORR
 - 123 - ELEC
 - 128 - ELEC.
 - 102 - ELEV.
 - 114 - EXERCISE
 - 115 - EXIT PASSAGEWAY
 - F 101 - Facil BAS Assets
 - 122 - FDC
 - IBB 101 - IBB BAS Assets
 - IBB 101 - IBB MEP Assets
 - 110 - JAN.
 - 116 - LOBBY
 - 113 - LOCKERS
 - 126 - Main Electrical Room
 - 129 - MDF/EF The Cage
 - 125 - PLUMBING
 - 120 - RECYCLING
 - 121 - RETAIL 2

Navigation

Label Style

AA

Scale FT

Zoom Fit (F)

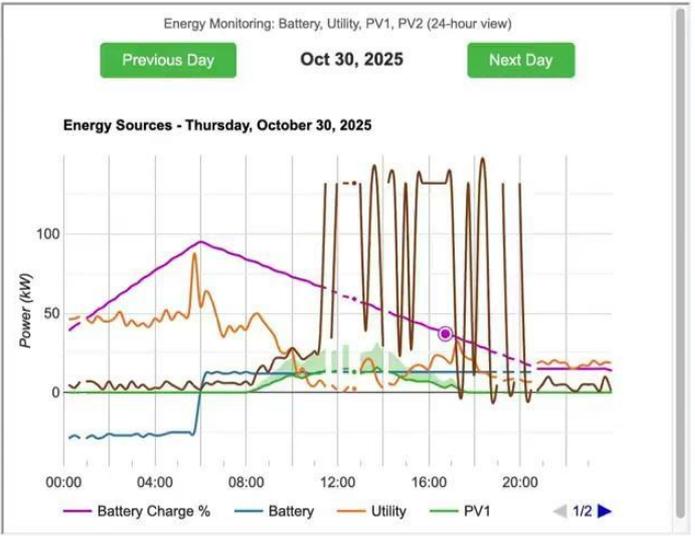
Zoom In

Zoom Out

Cycle Selection (Y)



PAE Smart Living Building (IBB-1)



Building Information

04-Initial Occupancy Year	[04-Initial Occupancy Year]	72-Building Age	[72-Building Age]
07-Gross Area	[07-Gross Area]	08-E and G Status	[08-E and G Status]
11-Floors	9 Floors	13-Historic	[13-Historic]
14-Link 1	Link 1	15-Utilities and Energy Link	15-Utilities and Energy Link
18R-Projects	[18R-Projects]	19R-Number of	[19R-Count the

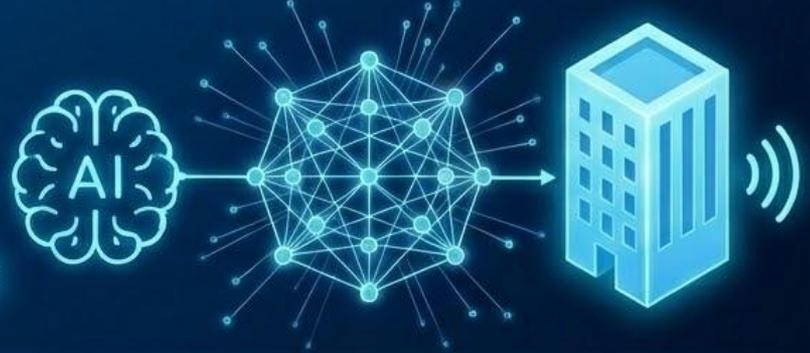


THIS IS THE GROUNDING LAYER AI HAS BEEN MISSING

AI Is Hallucinating Because Our Buildings Are Mute.



-  AI researchers lack real building data
-  Synthetic data fills the gap poorly
-  Buildings already generate reality
-  Semantics make that reality legible
-  Maintenance keeps it trustworthy



“ You can’t have a smart building with dumb data. Semantics is the language AI speaks.” ”

AI doesn’t need smarter models, it needs buildings that can speak.

Operational Proof: The Ice Cream Case Workflow

MILESTONE ACHIEVED: The Digital Twin Handshake

Milestone: BIM object selection shows live time-series telemetry.

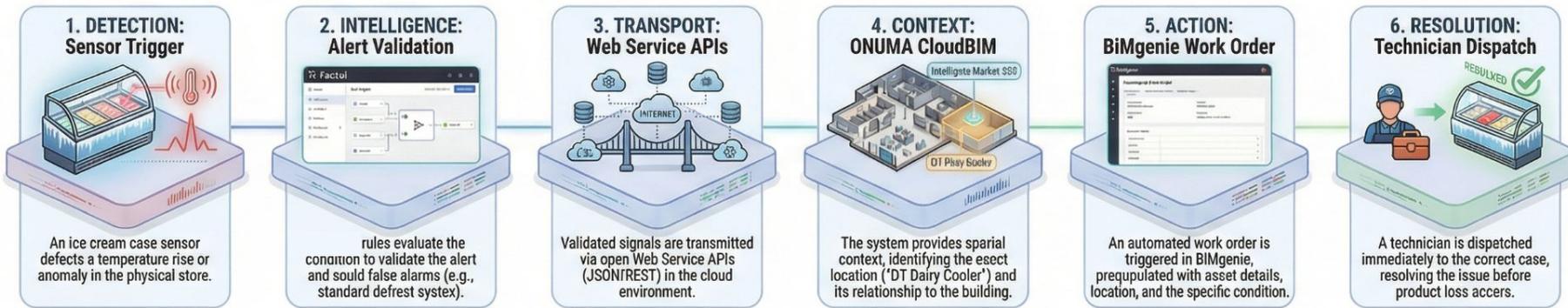
The Handshake: Geometry ↔ Asset ↔ Telemetry.



This connection ensures that 3D spatial data, unique asset identifiers, and real-time sensor streams are synchronized as a single source of truth.

"Each system does what it does best." Sensing, decisioning, contextualizing, and executing are distributed across specialized platforms rather than one monolithic silo.

OPERATIONAL WORKFLOW: THE ICE CREAM CASE SCENARIO



NEXT-PHASE INTELLIGENCE: ZAIMAP AI (PROTOTYPE/EARLY STAGE)



ZAIMAP: "Conversations with the Building"

[Early Stage / Prototype] AI initiates contextual queries like "Find the gateway, which room is it in?"

Status: Read-Oriented: Currently in the "Next Phase" of development, the AI uses CloudBIM structures to establish situational awareness.

Future Maturity: As mappings mature, these will evolve into operational commands and predictive maintenance conversations.

OPERATIONAL OUTCOMES & VALUE

PREVENT PRODUCT LOSS



Immediate detection and dispatch prevent the loss of temperature-sensitive inventory.

FASTER RESPONSE & LESS SEARCH TIME



Eliminates the "30% of a technician's day" typically wasted searching for rooms, assets, and data.

UPTIME OPTIMIZATION



Proactive workflows ensure critical systems remain operational with minimal manual discovery required.

Convergent Paths to the Living Digital Twin: Why Meaning Matters More Than Geometry



30% of Technician Time is Wasted.
Searching for rooms, assets, data in proprietary dashboards.



The Universal Challenge: "Spaghetti Data"
Data is Plentiful, but Fragmented and Unusable.

Smarter islands in a rising sea of data; raw connections, chaotic, no standard language.

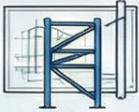
The \$100k+ "Handover Gap."
Massive costs to recompile data, 6-19 month delay before operational.



PAE Path: Deep Design



High-fidelity BIM models



Structural schematics

Deep Design.

Structured, heavy BIM for energy & structural integrity.

"Progress comes from connection, not perfection."



Years of Planning

Energy modeling

Years of Planning

ONE Destination: The Unified Digital Twin

Geometry, identity, and relationships converge for operational intelligence.



Market Path: Agile Deployment



Agile Deployment.

Rapid, API-driven for real-time sensors & immediate asset management.

"Start with what you have."



Real-time sensor data streams



Sensor streams



Bootstrap a twin.

The Destination: Meaning Over Geometry.

Data Alone is Noise; Context Creates Meaning.

A system of systems that knows what it is looking at and is connected to the building's present reality.



Success is measured by ability to act—triggering a work order automatically when a sensor detects a temperature spike.

The Living Operational Backbone.

Moving from a "Digital Dead End" (static files) to an open, semantic cloud that evolves throughout the building's lifecycle.



C4SB Foundation

The C4SB Foundation is a coalition dedicated to fostering the implementation of interoperable smart information systems in...

10 followers United States of America https://c4sb.org company/c4sb @C4SB_org

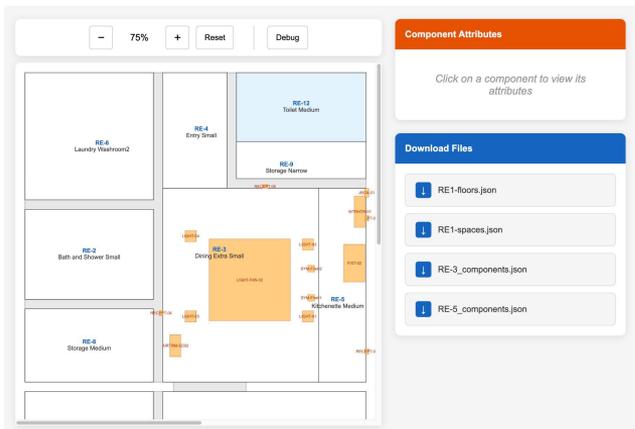
Overview Repositories 14 Projects Packages People

README.md



The Coalition for Smarter Buildings (C4SB), now part of the Linux Foundation as C4SBF, serves as an open-source initiative dedicated to revolutionizing building automation and IoT interoperability. It provides foundational reference models, standardized schemas, and open APIs designed to enable seamless data exchange across a diverse ecosystem of sensors, controls, software platforms, and vendor systems.

By fostering a collaborative community of manufacturers, software providers, integrators, and end-users, C4SBF accelerates the development and adoption of plug-and-play building technology, helping unlock smarter, more efficient, and future-proof building environments.



C4SBF / slimbin Public generated from C4SB/new-project

Code Issues Pull requests Actions Projects Security Insights

Files

- main
- github
- cloudbim-api
- docs
 - README.md
 - docs
 - sample-bim-semantic-model
 - sample-sensors
 - 1-getting-data
 - 2-displaying-data
 - README.md
 - docs
 - storyboards
 - License.md
 - README.md

slimbin / sample-sensors / 2-displaying-data

thomas-dalbert creating a sensor sample branch 9018f22 · 2 months ago History

Name	Last commit message	Last commit date
..		
README.md	creating a sensor sample branch	2 months ago

README.md

Displaying sensor data

The CMMS System in the cloudBIM displays the sensor data with various views supporting the facilities team with an easy to use interface. They can react to any anomalies quickly and adjust the BAS settings.

Plan views and graphic displays

At building level, Battery, Utility, and PV data shows any anomalies:

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slimbin / cloudbim-api

RE1 sample BIM API access

Various endpoints with specifically passed fields and filters will return simple geometry information and asset data which can be used in a third party application like the CMMS: PADI, Dabbleflow, and others or directly turned into a plan and asset data App like the RE1 API Request Visualization.

API Endpoints:

- Floors:
 - [https://system.onuma.com/\(\(sysID\)\)/api/items/building/3546?fields=floors.slabs.placement_x,floors.slabs.placement_y,floors.slabs.placement_angle,floors.slabs.profile](https://system.onuma.com/((sysID))/api/items/building/3546?fields=floors.slabs.placement_x,floors.slabs.placement_y,floors.slabs.placement_angle,floors.slabs.profile)
 - Response: RE1-floors.json
- Spaces/Rooms:
 - [https://system.onuma.com/\(\(sysID\)\)/api/items/space?fields=id,number,name,area,profile,placement_x,placement_y,placement_angle&filter\[floor/building\]=3546](https://system.onuma.com/((sysID))/api/items/space?fields=id,number,name,area,profile,placement_x,placement_y,placement_angle&filter[floor/building]=3546)
 - Response: RE1-spaces.json
- Assets/Components:
 - Assets Space RE-3: [https://system.onuma.com/\(\(sysID\)\)/api/items/space/339943?fields=id,number,name,components.component.instance_name,components.component.id,components.component.placement_x,components.component.placement_y,components.component.placement_angle,components.component.mirror_y,components.component.dimension_x,components.component.dimension_y,components.component.attributes](https://system.onuma.com/((sysID))/api/items/space/339943?fields=id,number,name,components.component.instance_name,components.component.id,components.component.placement_x,components.component.placement_y,components.component.placement_angle,components.component.mirror_y,components.component.dimension_x,components.component.dimension_y,components.component.attributes)
 - Response RE-3: RE-3_components.json
 - Assets Space RE-6: replace space id with space/339947
 - Response RE-6: RE-5_components.json

Visualization

This Plan Visualization App created with javascript for demonstration purposes shows how easily an App can use the response data from the cloudBIM API above.

Building Committee

buildingsmart.us



Jay Kline
Member
(NIBS)



Kimon Onuma
Co-Chair
(Onuma Inc.)



Luke Faulkner
Co-Chair
(BIMForum & AISC)

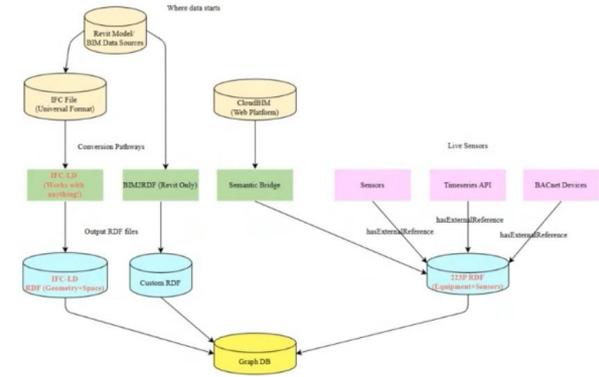


Roger Grant
Co-Chair
(NIBS)

Dennis Sheldon of Rensselaer Polytechnic Institute (RPI) & Researchers: Joseph Aerathu of Georgia Tech, Ahosan Habib of RPI

```
aligned_sensors.py  
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13 # DT API Credentials  
14 PROJECT_ID = 'cio6cburc3pjoj50skeg'  
15 KEY_ID = 'deg38bb24tn000b24tgg'  
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```
PS E:\223p\Codes> python aligned_sensors.py  
Last update: 2026-02-26T15:22  
  
Desk Occupancy Sensor 10  
Device ID: c95b145bd0qg009hvvvg  
Status: VACANT  
Last update: 2026-02-26T15:29  
  
Desk Occupancy Sensor 11  
Device ID: c9h3vqfck9200emrj0  
Status: VACANT  
Last update: 2026-02-26T15:29  
  
Desk Occupancy Sensor 12  
Device ID: c9h40ecq1dg009f19jg  
Status: OCCUPIED  
Last update: 2026-02-26T15:51  
  
Desk Occupancy Sensor 13  
Device ID: c9h40knck9200emrn90
```



IFC-LD as a Complementary Pathway for BIM-to-Semantic Web Integration

The collage includes:

- A 3D BIM model of a building structure.
- A terminal window with a query: "What sensors are in Office?" and a response: "[GraphRAG evidence collected - 0 nodes, 0 edges] [Set OPENAI_API_KEY for natural language answers.]".
- A GraphDB interface showing a "Graphs overview" with a search bar and a list of graphs.
- A smartphone displaying a presentation slide with a video call overlay.

Keynote Speaker

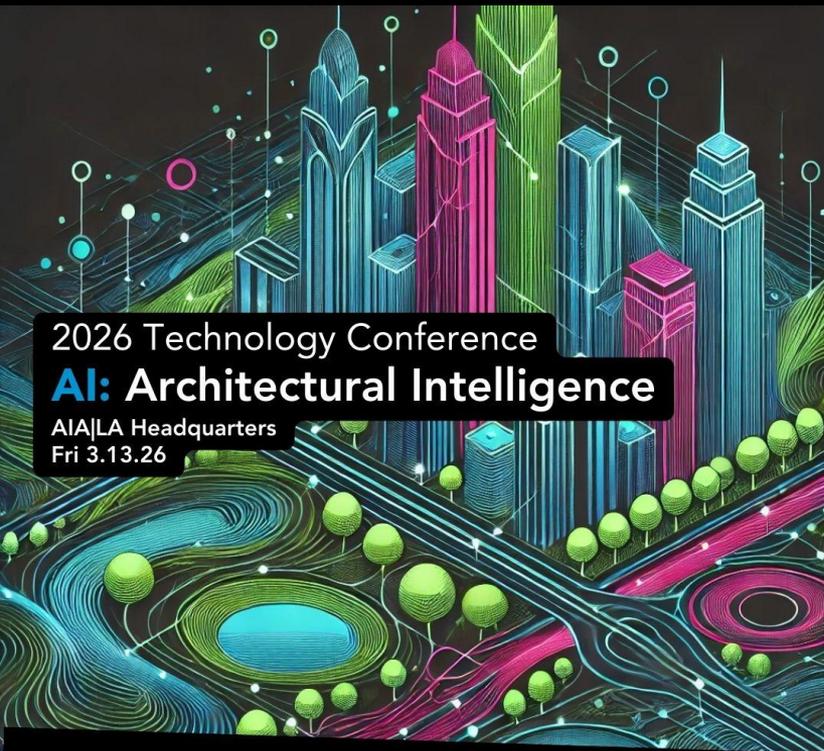


Kimon Onuma, FAIA
Onuma, Inc.

Presentation

THE ARCHITECTURE OF INTELLIGENCE: MEASURING
WHAT MATTERS (AND TURNING BUILDINGS INTO
LIVING SYSTEMS)

AI: Architectural Intelligence



2026 Technology Conference

AI: Architectural Intelligence

AIA|LA Headquarters
Fri 3.13.26

Friday, March 13th, 2026
8:00 am - 4:00 pm
4450 W Adams Blvd, Los Angeles, CA 90016

TAP + Professional Practice
Committees



Fri March 13th | 8am - 4pm
4450 W Adams Blvd, Los Angeles, CA 90016



MODELS TO MEANING



Stephen Lothrop
PAE



Tristan de Frondeville
SkyCentrics



Kimon Onuma
ONUMA

