Automating Campus Dashboards Using Haystack

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National Renewable Energy Laboratory

2019 Haystack Connect

Smart Data. Smart Devices. Smart Buildings. Smart Business.

Learning Objectives

1. Understand how Haystack enables dashboard automation
2. See some practical examples of Haystack-enabled dashboards
3. Review challenges and solutions for dashboard automation

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Image: Warren Gretz, NREL

Image: Dennis Schroeder, NREL

Circa 2003

Facility Floor Area: 323,776 ft^2

Occupants: ~450

Circa 2018

Facility Floor Area: 967,390 ft^2 (+198%)

Occupants: ~2100 (+367%)

NREL's Energy Management & Information System

22,842 Data Streams

Electricity Meters

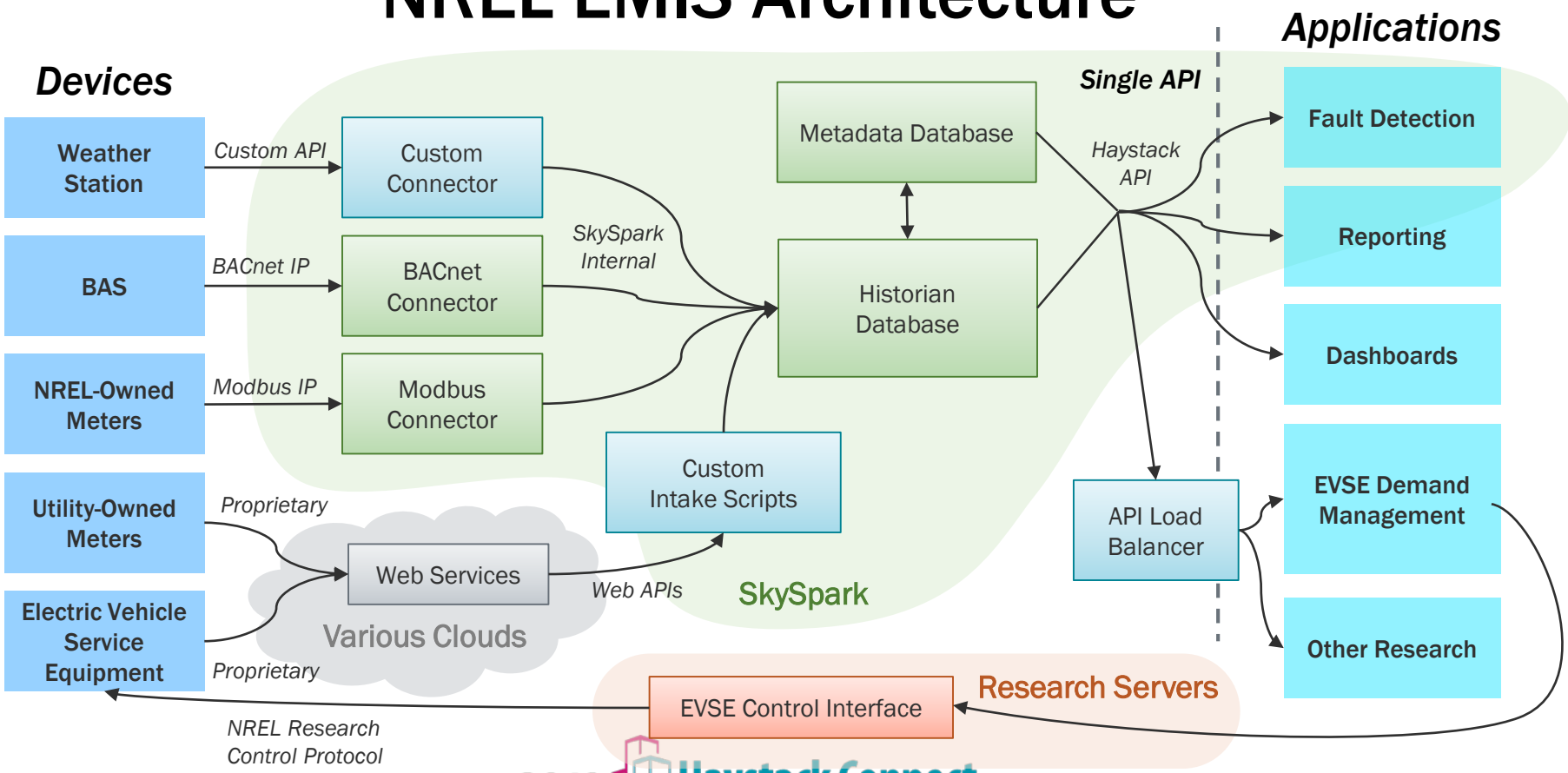
Building Automation Systems

Onsite Generation

Electric Vehicle Service Equipment

Weather Measurements, Forecasts

NREL EMIS Architecture



NREL's Dashboard Goals

Provide information to campus **occupants**

Provide visibility to facility **operators**

Provide insight for **business decision makers**

Most dashboards still use manually-configured communication links

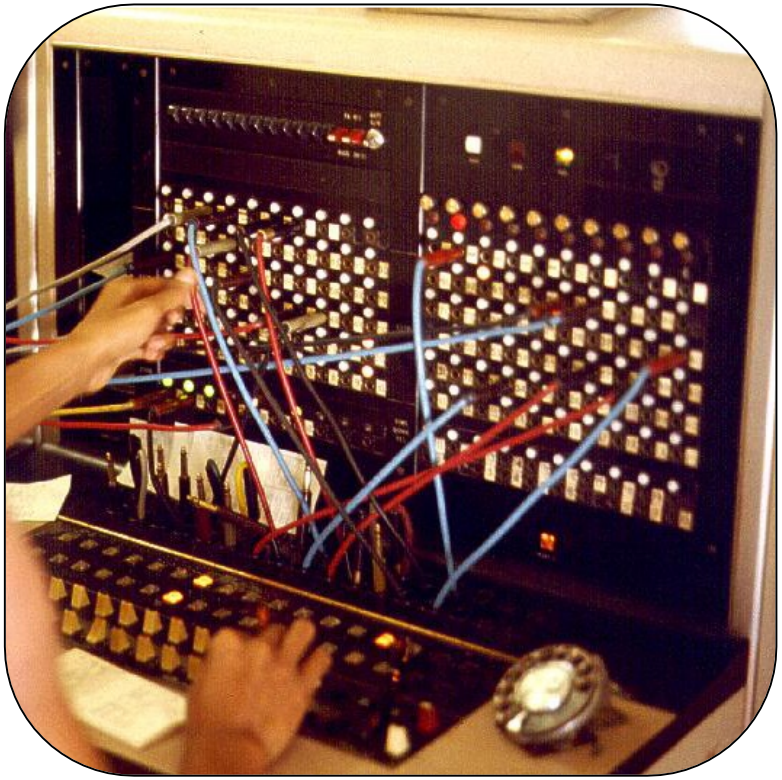
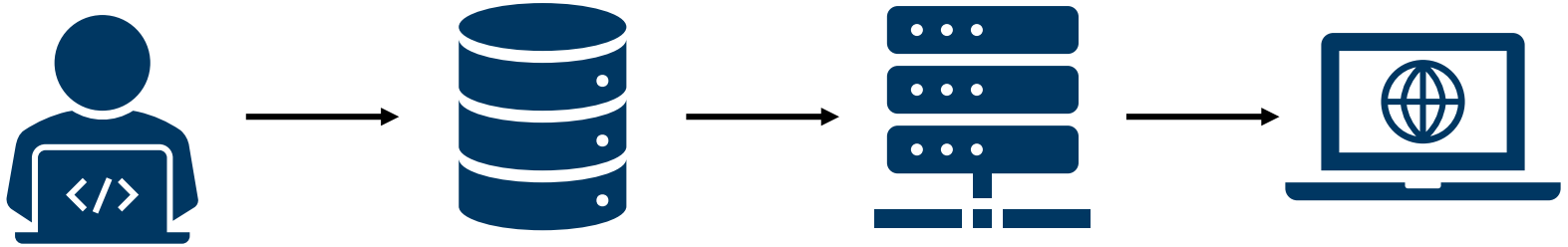


Image: Joseph A. Carr, Wikipedia (used with permission)

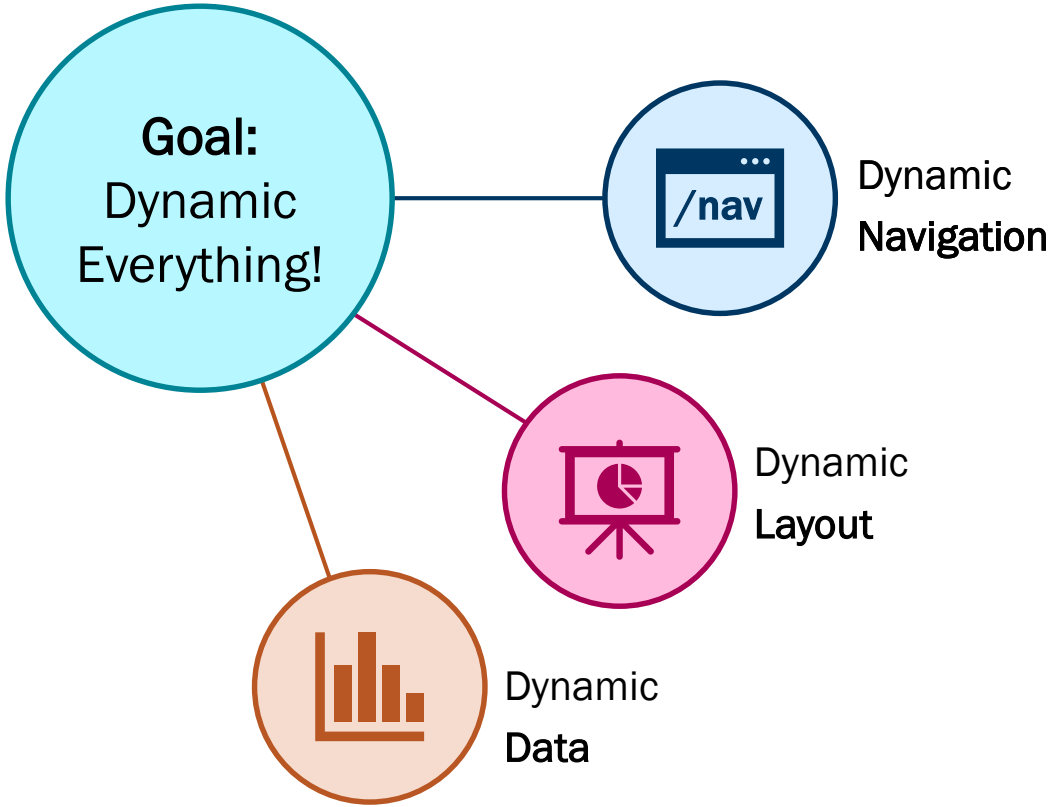
When an operator modifies facility information…



…all dashboards update automatically

Our design philosophy:

Automate dashboard generation using Haystack



Benefits:

Portability

Scalability

Minimal
Maintenance

Q. How does it work?

A. Tie modular UI elements to Haystack queries


STM Campus
Thu May 9 11:22 PM
AFUF
Cafe
EC
ESEB
ESIF
FTLB
Garage
HFSF
IBRF
Mesa Top
OTF
RSF2
XCEL METER 4152.55 kW
SITE PV ???
Powered by: Intelligent Campus
NREL


STM Campus
Thu May 9 11:22 PM
Query: site
AFUF
Cafe
EC
ESEB
ESIF
FTLB
Garage
HFSF
IBRF
Mesa Top
OTF
RSF2
XCEL METER 4152.55 kW
SITE PV ???
Powered by: Intelligent Campus
NREL


STM Campus
Thu May 9 11:23 PM
AFUF
Cafe
Timeseries
Performance
EC
ESEB
ESIF
FTLB
Garage
HFSF
IBRF
Mesa Top
XCEL METER 4152.55 kW
SITE PV ???
Powered by: Intelligent Campus
NREL


STM Campus
Thu May 9 11:23 PM
AFUF
Cafe
Timeseries
Performance
EC
ESEB
ESIF
FTLB
Garage
HFSF
IBRF
Mesa Top
{site, dis:"Cafe", …}
Autogenerated Navigation:
http://intelligentcampus.nrel.gov/#/building/cafe/
XCEL METER 4152.55 kW
SITE PV ???
Powered by: Intelligent Campus
NREL

Fri May 10 11:56 AM

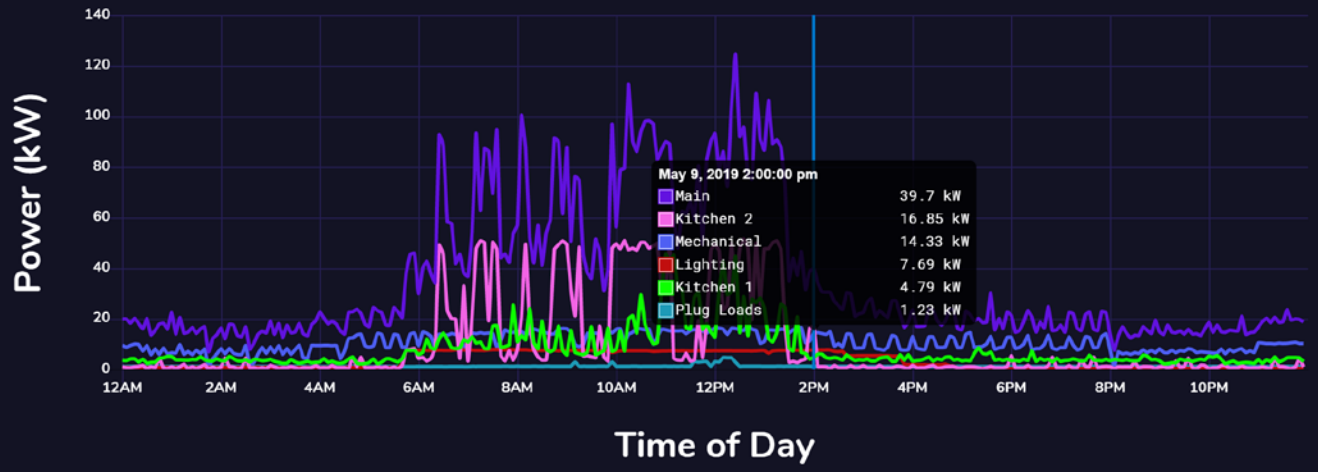
Display Date

2019-05-09

Line | Radial

- Main
- Kitchen 1
- Kitchen 2
- Lighting
- Mechanical
- Plug Loads

Reset Zoom

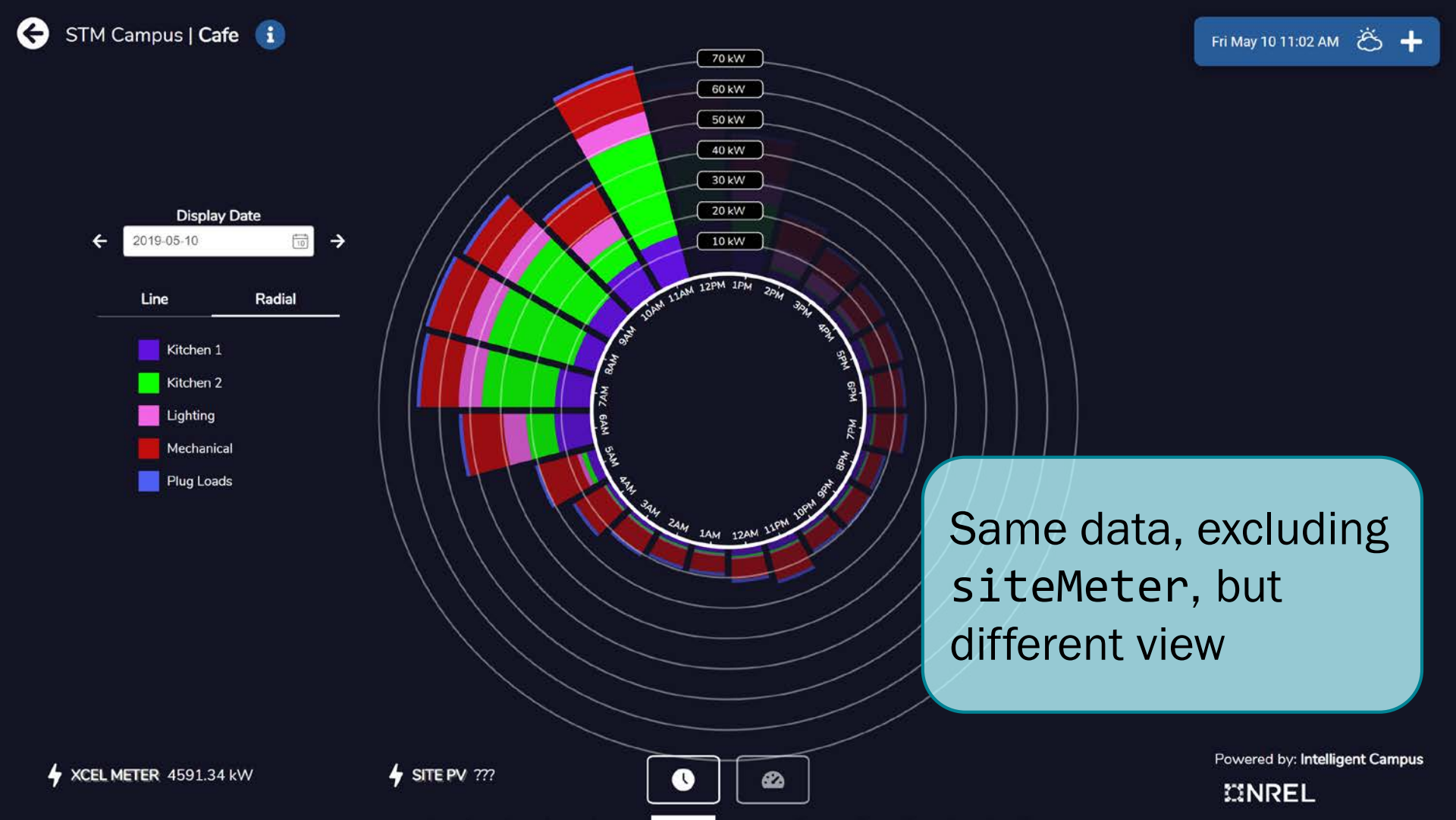


XCEL METER 3936.66 kW

SITE PV ???

Powered by: Intelligent Campus

NREL


STM Campus | Cafe
Fri May 10 11:02 AM
70 kW
60 kW
50 kW
40 kW
30 kW
20 kW
10 kW
12AM 1AM 2AM 3AM 4AM 5AM 6AM 7AM 8AM 9AM 10AM 11AM 12PM 1PM 2PM 3PM 4PM 5PM 6PM 7PM 8PM 9PM 10PM 11PM
Display Date
2019-05-10
Line
Radial
Kitchen 1
Kitchen 2
Lighting
Mechanical
Plug Loads
Same data, excluding siteMeter, but different view
XCEL METER 4591.34 kW
SITE PV ???
Powered by: Intelligent Campus
NREL

STM Campus | Cafe

Fri May 10 11:56 AM

Café
Primary Function: Food Service
Year Built: 2012
Area: 12140 ft²

{site, dis:"Cafe", area:12140ft², …}

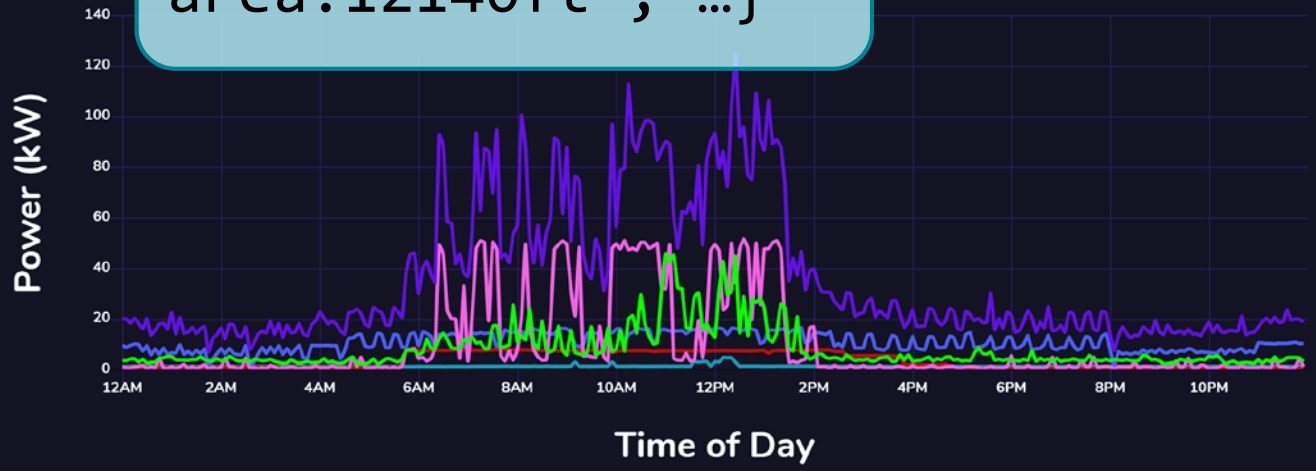
Display Date

2019-05-09

Line | Radial

- Main
- Kitchen 1
- Kitchen 2
- Lighting
- Mechanical
- Plug Loads

Reset Zoom



XCEL METER 3936.66 kW

SITE PV ???

Powered by: Intelligent Campus

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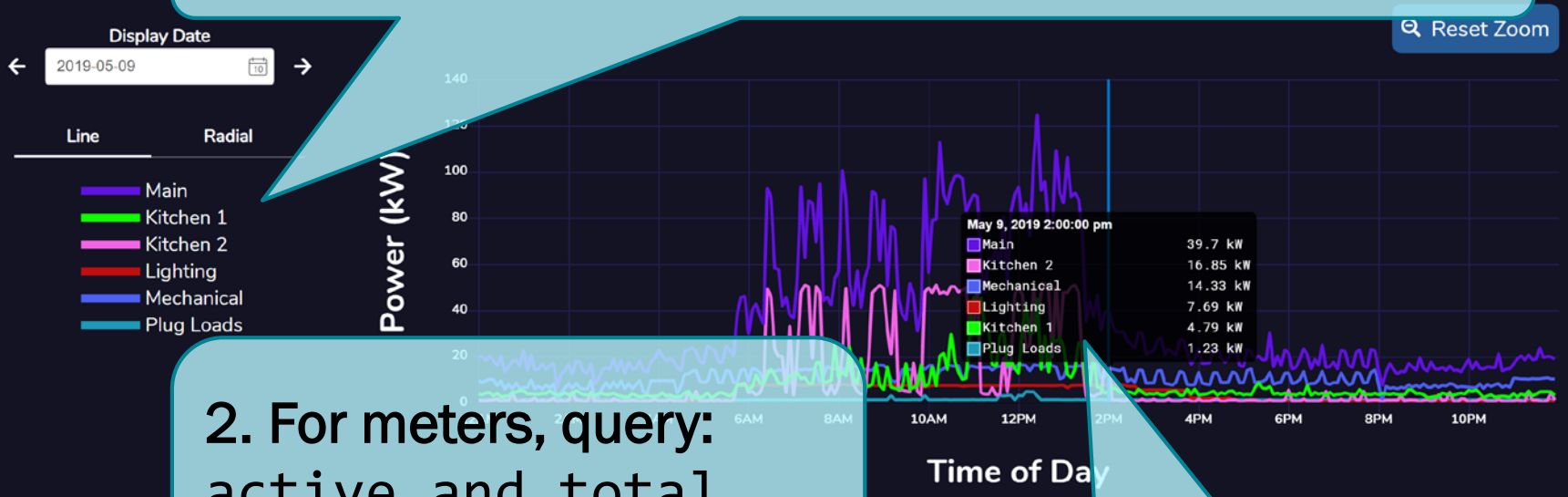
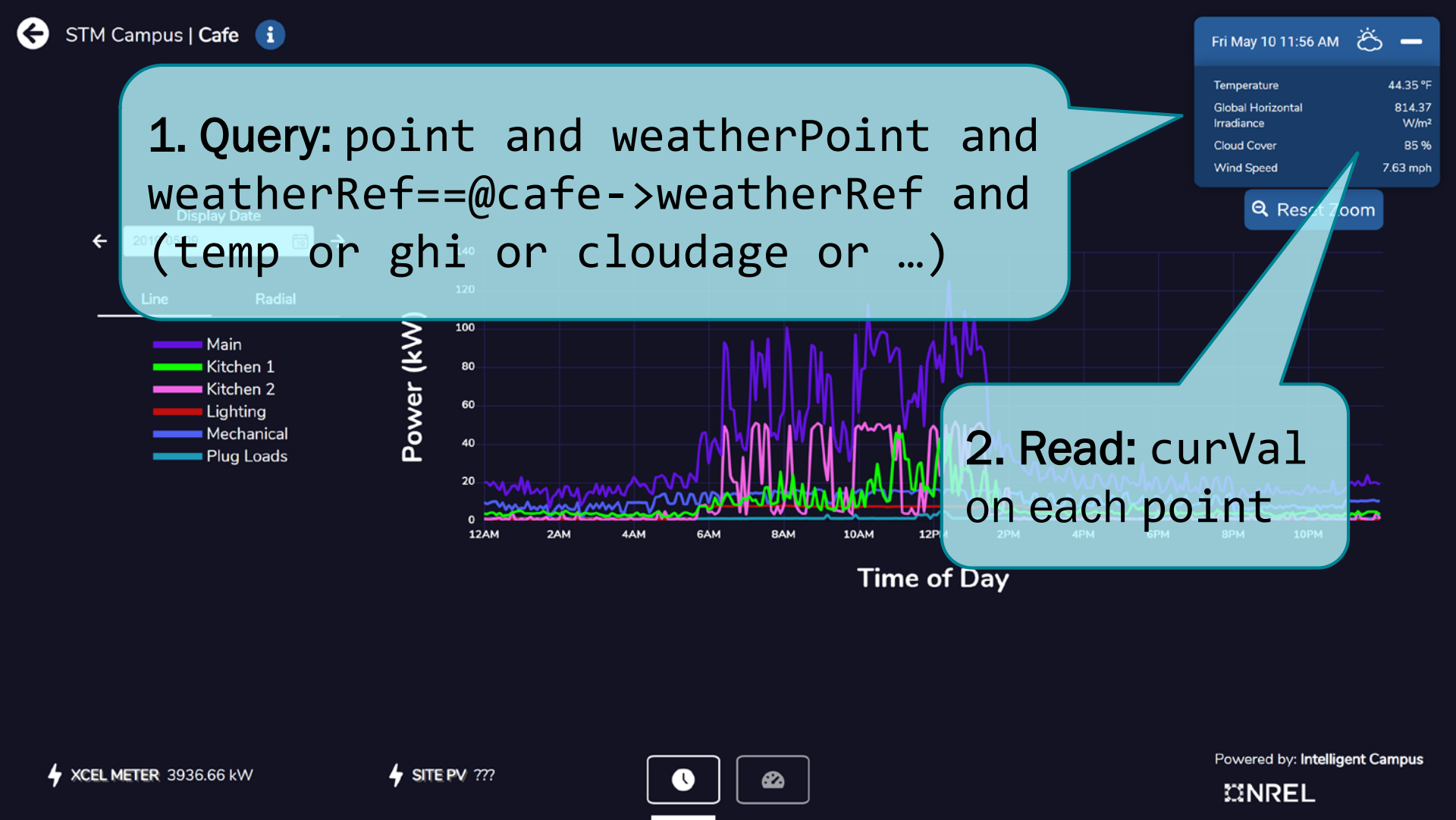
1. Query: `elec and meter and siteRef==@cafe`



2. For meters, query: `active and total and power and point`

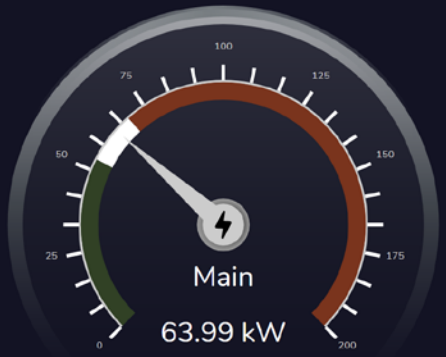
3. Read History


STM Campus | Cafe
1. Query: point and weatherPoint and weatherRef==@cafe->weatherRef and (temp or ghi or cloudage or …)
Fri May 10 11:56 AM
Temperature 44.35 °F
Global Horizontal Irradiance 814.37 W/m²
Cloud Cover 85 %
Wind Speed 7.63 mph
Reset Zoom
Display Date
Line
Radial
Main
Kitchen 1
Kitchen 2
Lighting
Mechanical
Plug Loads
Power (kW)
120
100
80
60
40
20
0
12AM
2AM
4AM
6AM
8AM
10AM
12PM
2PM
4PM
6PM
8PM
10PM
Time of Day
2. Read: curVal on each point
XCEL METER 3936.66 kW
SITE PV ???
Powered by: Intelligent Campus
NREL

STM Campus | **Cafe**

Fri May 10 11:01 AM

Kitchen 1 15.12 kW



Kitchen 2 21.07 kW

Lighting 7.74 kW

Mechanical 15.06 kW

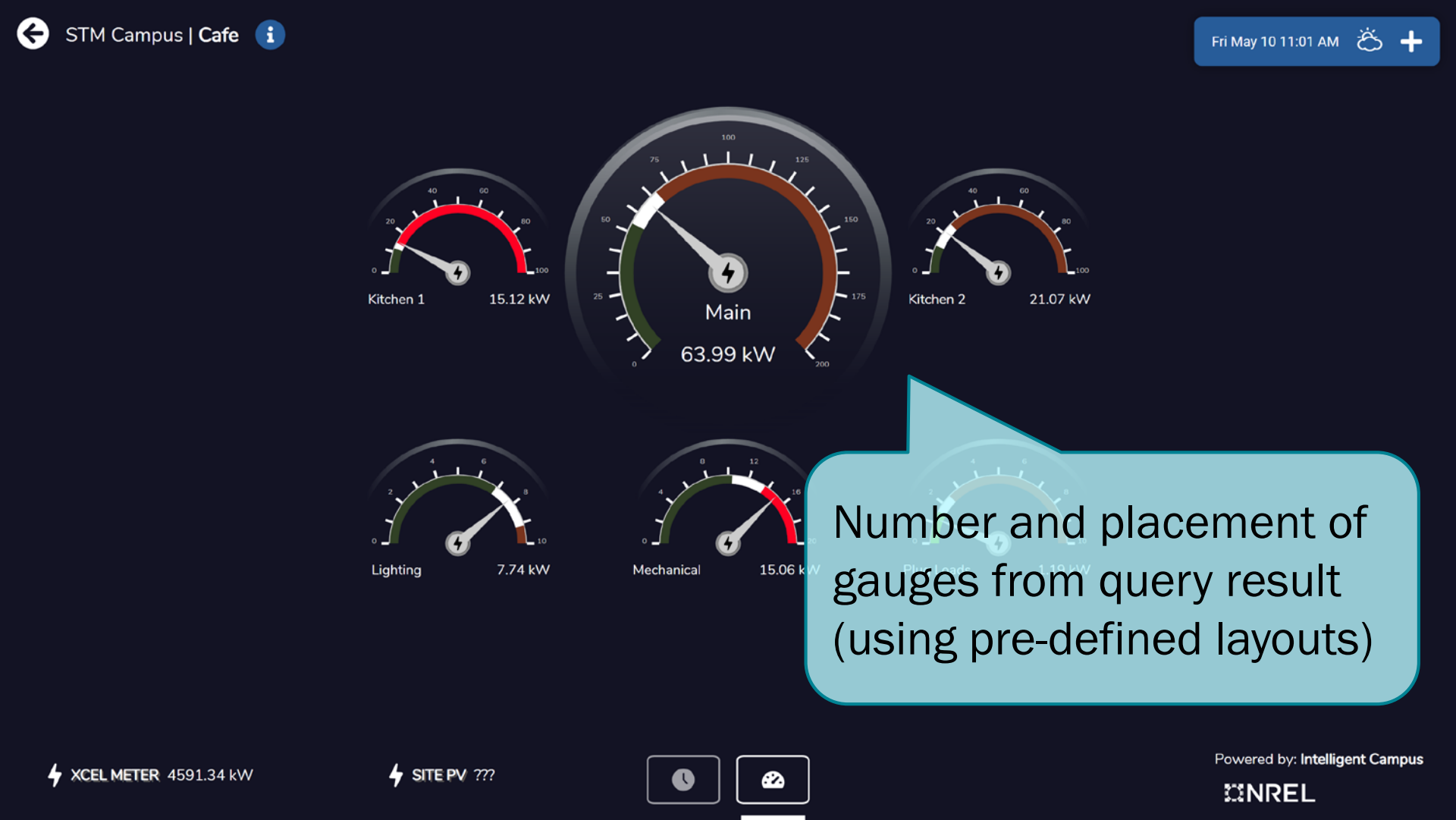
Plug Loads 1.19 kW

XCEL METER 4591.34 kW

SITE PV ???

Powered by: **Intelligent Campus**

NREL


STM Campus | Cafe
Fri May 10 11:01 AM
Kitchen 1
15.12 kW
Main
63.99 kW
Kitchen 2
21.07 kW
Lighting
7.74 kW
Mechanical
15.06 kW
Number and placement of gauges from query result (using pre-defined layouts)
XCEL METER 4591.34 kW
SITE PV ???
Powered by: Intelligent Campus
NREL


2019-05-10
Lighting
Lighting kW
10
8
6
4
2
0
-2
12AM
2AM
4AM
6AM
8AM
10AM
12PM
2PM
Time of Day
May 10, 2019 10:35:00 am
Expected Range Max 8.71 kW
Lighting 7.66 kW
Expected Range Min 6.38 kW
Expectation models built automatically from historical meter data

Prediction Points

navName: “Real Power Total”
id: @p:nrel:r:4
point: ✓
sensor: ✓
active: ✓
power: ✓
total: ✓
unit: “kW”
equipRef: @p:nrel:r:3 “Main Meter”
spaceRef: @p:nrel:r:2 “Meters”
siteRef: @p:nrel:r:1 “Cafe”
…

navName: “Real Power Prediction”
id: @p:nrel:r:5
point: ✓
prediction: ✓
predictionOf: @p:nrel:r:4
predictionAlgorithm: “ANN"
predictionConfig: { … }
equipRef: @p:nrel:r:3 “Main Meter”
…

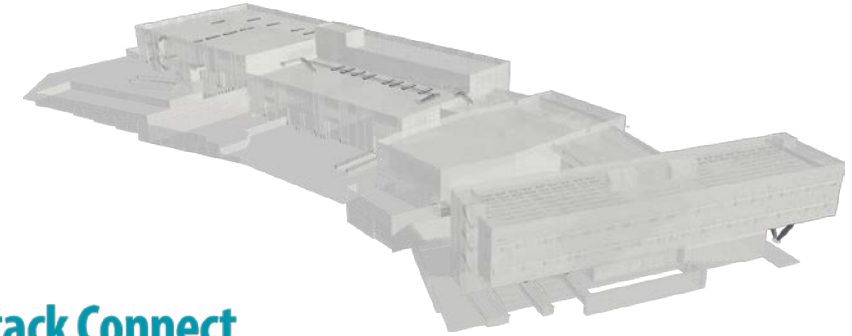
navName: “Real Power Upper Bound”
id: @p:nrel:r:6
point: ✓
prediction: ✓
predictionOf: @p:nrel:r:4
predictionAlgorithm: “ANN"
predictionConfig: { … }
ub: ✓ // Upper Bound
equipRef: @p:nrel:r:3 “Main Meter”
…

navName: “Real Power Lower Bound”
id: @p:nrel:r:7
point: ✓
prediction: ✓
predictionOf: @p:nrel:r:4
predictionAlgorithm: “ANN"
predictionConfig: { … }
lb: ✓ // Lower Bound
equipRef: @p:nrel:r:3 “Main Meter”
…

Challenges and Solutions

Challenge: Integrating Spatial Data

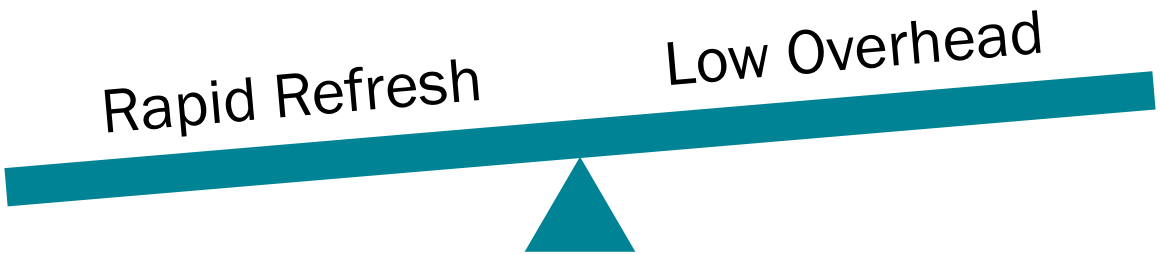
- Haystack has limited native support for geospatial or 2D/3D asset information
- **(Partial) solution:** cross-reference to an external graphical asset store
- **Drawback:** still requires updates in two places



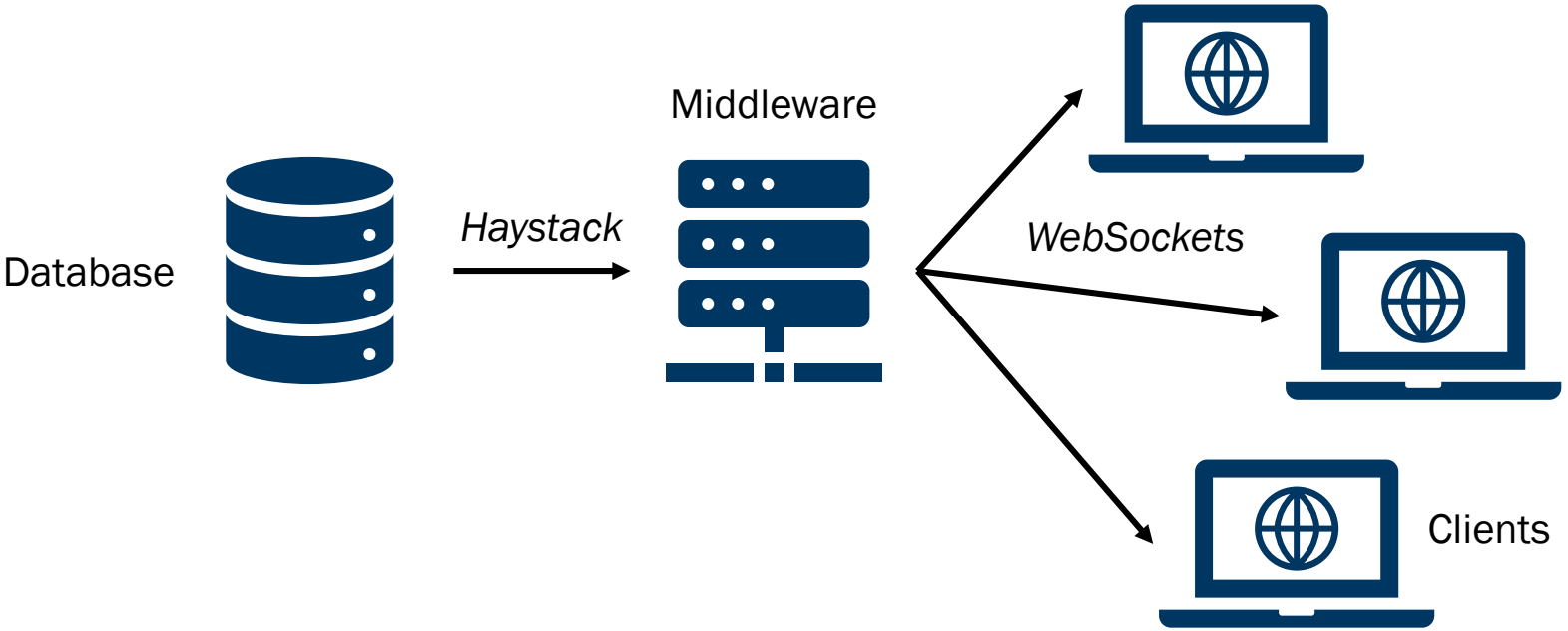
Challenge: API Limitations

- **Client must initiate communication:**
  Many clients ⇒ many API calls
- **hisRead op is one point only:**
  Many points ⇒ many API calls
- **Limited/unclear support for COV subscription:**
  Polling required to get updates (even with `watchSub`?)

Challenge: Manage Caching



(One Possible) Solution: Middleware



Roles of the Middleware

1. Manages rescan/refresh
2. Caches asset lists, metadata, navigation
3. Centralizes updates ⇒ reduces API traffic
4. Pushes new data to clients

Challenge: Filtering / Visibility Control

Sometimes, you don't want everything to show up…

- During setup/commissioning
- Important sites only
- Sensitive facilities

(One Possible) Solution: Filter with `dashboard` tag

Live Demo

Time and Technology Permitting…

Thank You!

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