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## Forge with BIM 360 Docs as an IoT Hub

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### Learning Objectives

- Learn how to use BIM 360 as an IoT hub
- Learn how to use BIM 360 Build to collect data
- Learn how to link equipment in the building with the BIM model in BIM 360 Docs
- Learn how to make predictive analysis from what you are seeing

### Description

What are the possibilities when we talk about IoT (Internet of Things) and BIM (Building Information Modeling)? Well, when we integrate through Forge intelligent models and Microsoft Azure IoT Hub, we can have a world of possibilities and insight with machine learning. In this lecture, you will see how data collected with BIM 360 software to make an inventory were connected with equipment in the building to monitor what was going on and make predictive analysis, in order to cut building maintenance costs.

### Speaker(s)

Tiago Ricotta is an architect and urban planner. He has a master's degree in planning and technology and a master's degree in business administration, project management professional (PMP). He received a Technical Highlight Award for Creativity and Innovation from Autodesk Brazil, and he has 14 years of experience in the architecture, engineering, and construction market. Today he is the Head of Business Development at Brasoftware Informatics, where he is responsible for integrating Microsoft Cloud with Autodesk and other Manufactures products to drive digital transformation in the clients of his company. Ricotta was an Autodesk Revit Gunslinger (2014) and Insider (2018) event participant, an Autodesk University Las Vegas Speaker (2012/2016/2018), and an Autodesk University Brazil speaker (2013/2014/2016), he is an Autodesk Revit Certified Professional. He was the technical responsible for the first LATAM BIM 360 Field / BIM 360 Plan / Building Ops software enterprise agreement contract and implementation.

## The beginning of a Revolution in the AEC Industry

It is not new that the AEC Industry is the industry that most need to improve when it comes to Digital Transformation, we have been dealing with manual and rework process for too long and that's leaving tons of money in the table.

Some examples of our difficult can be seen in a graphic from a research made by Box.com showing how is the typical collaboration in construction:

### Typical collaboration graph: construction

This graph shows a leading residential and commercial construction firm that shares blueprints and building plans with onsite external contractors via mobile devices. Workers also collaborate internally for back-office functions such as billing, payroll, reports, and logistics.

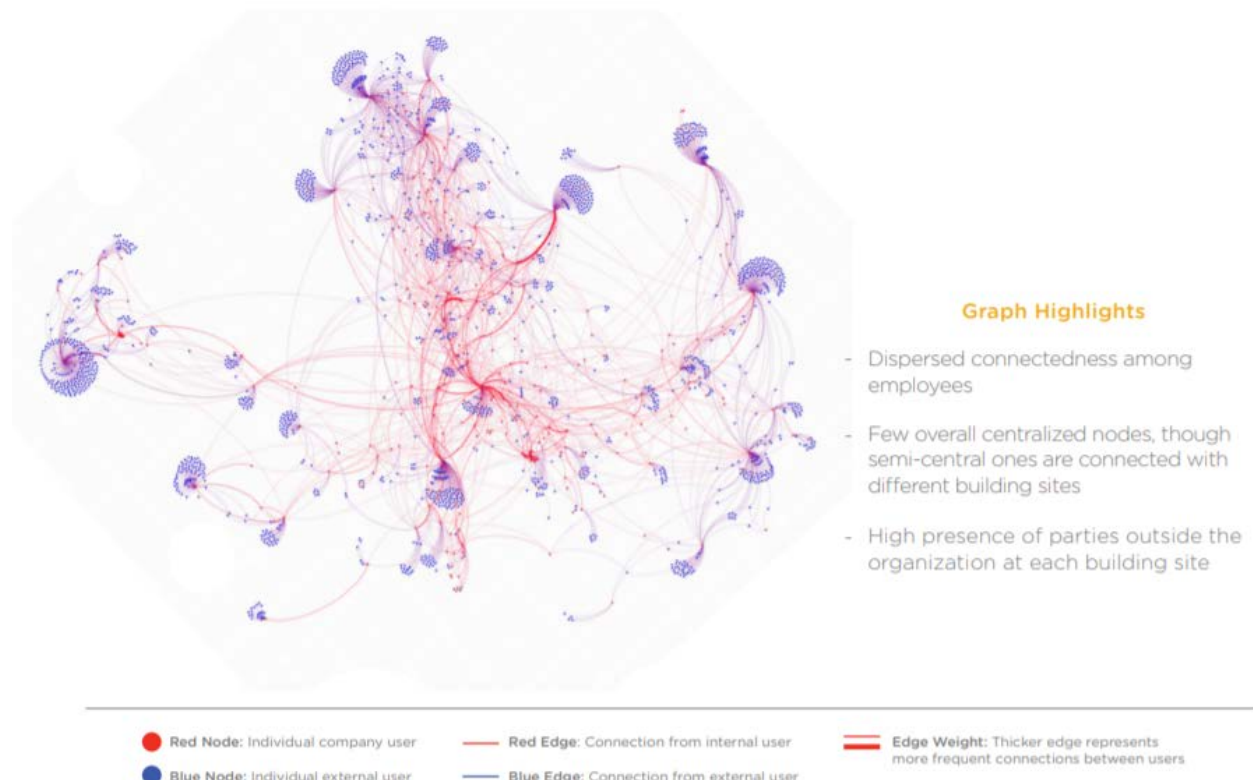


Figure 1 - Typical Collaboration graph

From this graph we can see how dispersed the information is in a construction organization, but how can we evolve the industry to drive Digital Transformation in the AEC market?

A good path would be to know which technologies are available for this matter. Autodesk cloud technology probably is one of the best technologies launched in the past few years in the BIM world that the mainstream hasn't discovered how to take advantage of that.

Basically, BIM 360 products and Autodesk Forge integrated with other public clouds such as Microsoft Azure can boost the AEC industry to drive Digital Transformation in a way that we won't need to use paper never again.

To understand how this can work have you heard the concept of a Digital Twin? This concept is at Gartner's Top Trends for 2017 and kept expectations for this and the following years in a way to change how things are operated today.

Says Gartner:

***"Trend No. 5: Digital Twin***

*Within three to five years, billions of things will be represented by digital twins, a dynamic software model of a physical thing or system. Using physics data on how the components of a thing operate and respond to the environment as well as data provided by sensors in the physical world, a digital twin can be used to analyze and simulate real world conditions, responds to changes, improve operations and add value. Digital twins function as proxies for the combination of skilled individuals (e.g., technicians) and traditional monitoring devices and controls (e.g., pressure gauges). Their proliferation will require a cultural change, as those who understand the maintenance of real-world things collaborate with data scientists and IT professionals. Digital twins of physical assets combined with digital representations of facilities and environments as well as people, businesses and processes will enable an increasingly detailed digital representation of the real world for simulation, analysis and control."*

Like it is described in Gartner's definition of a Digital Twin, in order to use this technology, we need a Digital Model of a Physical thing that can be a machine, an engine or a building.

The real question here is how we do that and what we do after creating a Digital Twin?

Dividing the answer in several parts, let's first check which are the technologies that can deliver the digital twin concept to life.

BIM 360 and Autodesk technology will deliver the Digital 3D Model, you will model things in Autodesk Inventor, Autodesk Revit, Autodesk InRoads and other modeling tools and BIM 360 can bring the cloud power technology to access these models anytime, anywhere in 3D.

Microsoft Azure can be the bridge that we need to collect data from sensors to connect them into the Digital World delivering also the sensors management. A complete vision a Digital Construction can be found in the figure 01:

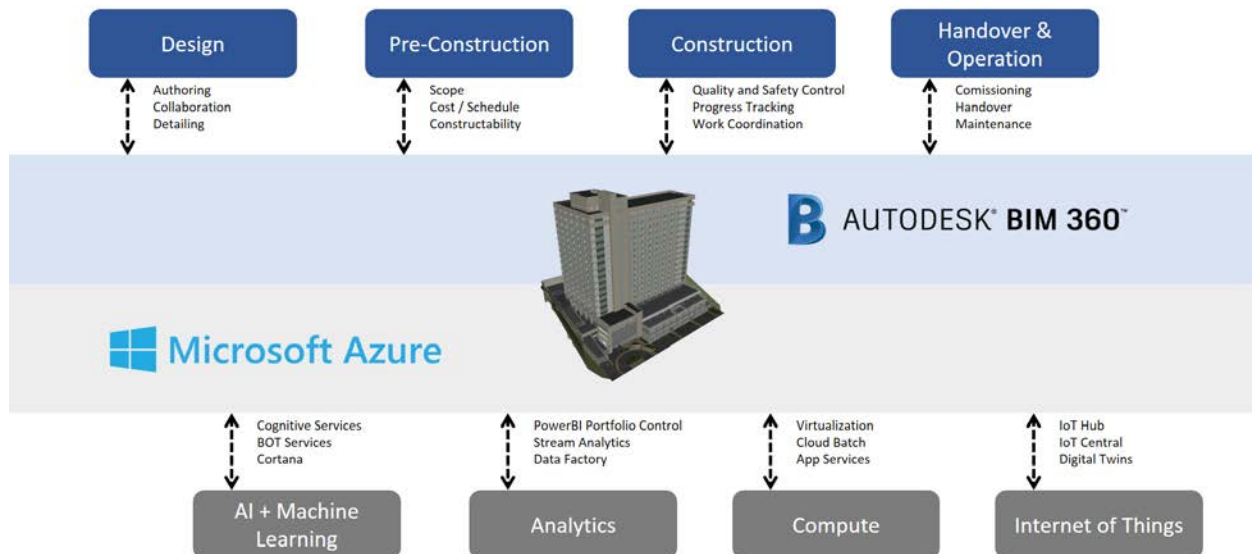


Figure 2 - The vision combined

A good way to understand this concept of integrating Autodesk BIM 360 with Microsoft Azure would be to think about Spider Man.

When Spider Man is discovering his powers, he made a homemade suite, but when Spider Man meets Iron Man Mr. Stark developed a new powerful suite, somehow is what happens with Autodesk BIM 360 being powered by Microsoft Azure, a good representation is showed below:

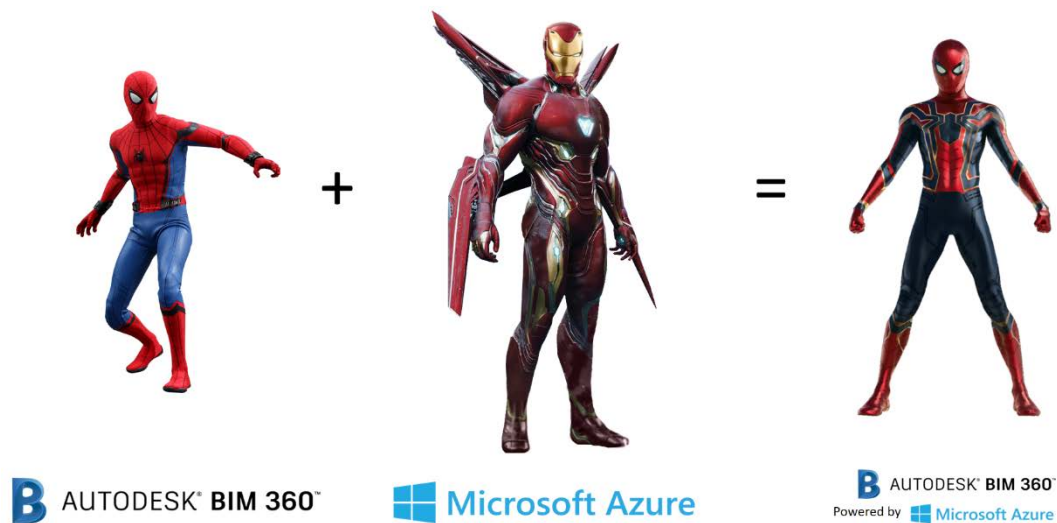


Figure 3 - Autodesk BIM 360 powered by Microsoft Azure

How this integration can be made? That's are our learning objectives.

## BIM 360 as an IoT hub

To start making the integration between Autodesk BIM 360 and Microsoft Azure we have to decide on what kind of information we will leave in each product.

In 2016 I had a lecture in AU called [BU18239: Useless or Priceless? How to Prepare and Use a BIM Model for FM and Building Ops](#). I showed how we can prepare a BIM Model to be used for Facility Management, that work was the base for this lecture.

In my opinion for a Digital Twin, after preparing the model for Facilities, we can use BIM 360 Docs to host the 3D model and access that in an external web application.

To do that I suggest you guys take a look in the [Getting Started](#) page of Autodesk Forge. Autodesk Forge is the open API of Autodesk BIM 360 where we can have access to all the tools for development and integration between Autodesk products and Microsoft Azure cloud.

For better understanding the architecture of the new web application the figure 4 shows how Autodesk would integrate with Microsoft to create a Digital Twin model:

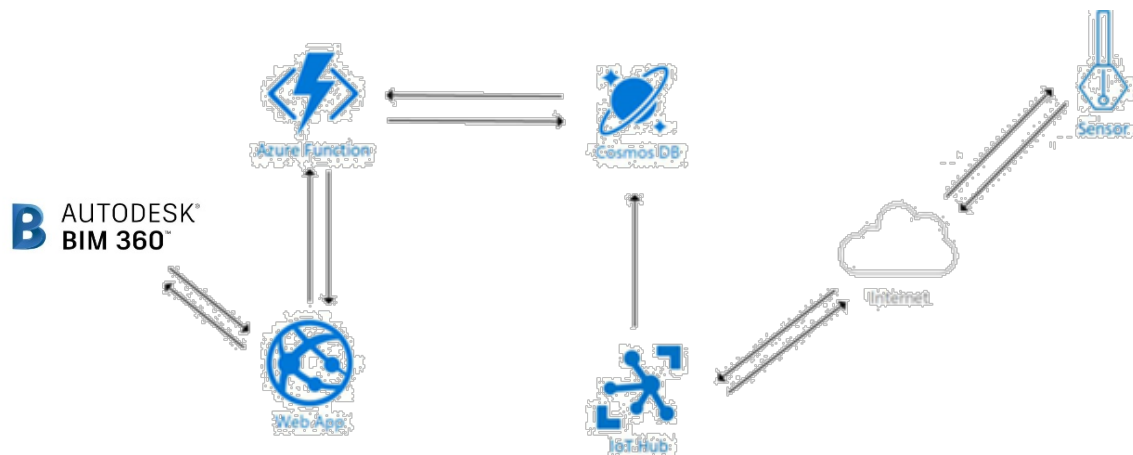


Figure 4 – digital twin concept

The web app is a new web application that will create the visualization of the model integrated with the data collected by the sensors. What are the sensors available in the market? Take a look:



Figure 5 – types of sensors

And what type of sensors we can use in this architecture? Pretty much every single one since it has these requisites:

- Data encryption with a provably secure, publicly analyzed, and broadly implemented symmetric-key encryption algorithm, such as AES with at least 128-bit key length.
- Digital signature with a provably secure, publicly analyzed, and broadly implemented symmetric-key signature algorithm, such as SHA-2 with at least 128-bit key length.
- Support for either TLS 1.2 (IETF RFC524698) for TCP or other stream-based communication paths or DTLS 1.2 (IETF RFC6347) for datagram-based communication paths. TLS-typical support of X.509 certificate handling is optional and can be replaced by the more compute-efficient and wire-efficient pre-shared key mode for TLS (“TLS/PSK,” IETF RFC427999), which can be implemented with support for the aforementioned AES and SHA-2 algorithms.
- Updateable key-store and per-device keys. Each device must have unique key material or tokens that identify it toward the system. The devices should be able to store the key securely on the device (for example, using a secure key-store). The device should be able to update the keys or tokens periodically, or reactively in emergency situations in case of system breach. Key update might occur over the air or through some other means, but updateability is required.
- The firmware and application software on the device must allow for updates to enable the repair of discovered security vulnerabilities.

Security is a big issue and you have to make sure that the connectivity to the cloud covers all these requirements. Also, as the IoT sensor is exposed and need a connection to your network it is an excellent idea to make a board security for these sensors.

If you don't think about board security the chance of hacker to use your IoT device connection to access your network increases a lot. Think about this architecture when it comes to board security:



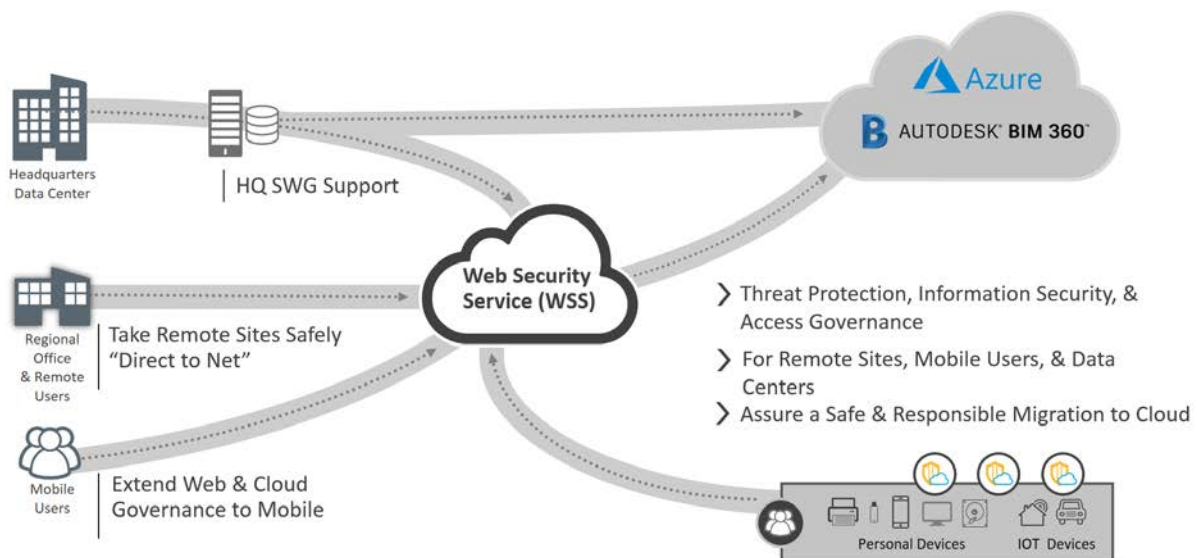


Figure 6 - web security service (WSS)

Remote users and mobile users from remote sites and also HQ locations can plug into the Web Security Service – universal connectivity capabilities. Connectivity issues are based upon what the business wants to do and what its requirements are. The core web security service is not only rock solid and very robust access governance for web and cloud use, but also very strong capabilities for threat protection, information security, data loss prevention, integrations, that give a very robust set of security compliance threat protection capabilities across all of these devices. Web Security Service is basically acting as a unifying bridge or gateway to the web and the cloud to ensure that your policies are being enforced consistently across all of these sorts of devices and locations. WSS Bring control to the chaos.

## BIM 360 Build to collect data

Even if my lecture in 2016 was based on BIM 360 Field and not BIM 360 Build things can still work. For sure in some point in the future there will be a new equipment workflow in BIM 360 Build like there was in BIM 360 Field.

To collect data with BIM 360 Build you can create a checklist with the following fields:

1
Equipment
Done

11 Equipment Code  
H005

12 Type  
H005\_FDE\_LavatórioIndividual\_semColuna

13 Name  
BRSP430\_430.01\_ZN01\_02F\_04837\_BS05\_SINK01

14 Description  
Sink without column 01

15 Room  
02F Bathroom 01

16 Status  
Installed

17 Maintenance Code  
D4837

18 Manufacturer  
Deca

19 Model  
P.501

110 Construction Company  
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Details
1/1 Section
10/10 Items

Assigned To:  
Tiago Ricotta

Location:  
Unspecified

Scheduled:  
Oct 29

Type:  
Commissioning

Description:  
Collect Equipment Data

Created by Tiago Ricotta, last updated by Tiago Ricotta on Oct 29

Figure 7 - BIM 360 Build equipment checklist

The checklist will be filled using a cellphone in the field, you will have to consult the BIM Model in stored in BIM 360 Docs using the preparation described in the 2016 lecture to see which code will be used.

In terms of systems the key to connect the Component at the BIM Model and the Component in Azure will be the parameter name, in our example will be a sink with the filled field as a "BRSP430\_403.01\_ZN01\_02F\_04837\_BS05\_SINK01"

In the future you will be able to use Forge API to rebuild the equipment feature in BIM 360 Build, it can be a way to solve the integration process and avoid making things so manually, especially because people in the field will have difficulties to follow this workflow.

Another strategy is to continue using BIM 360 Field equipment workflow until BIM 360 Build has equipment's. I would suggest to the Field workflow instead of Build until the product become more mature.

You can follow the example of the 2016 lecture to know how to collect data using Field and integrating with the model.



## Link equipment in the building with the BIM model in BIM 360 Docs

To Link the equipment in BIM 360 Docs (Digital Model) to the equipment in a building (Physical Model) you will need to make a new web application that will integrate the data of both world.

In order to do that the new application will call BIM 360 using these line of codes:

```
// urn = 'dXJuOmFkc2sub2JqZWN...'
function launchViewer(urn) {
  var options = {
    env: 'AutodeskProduction',
    getAccessToken: getForgeToken
  };
  var documentId = 'urn:' + urn;
  Autodesk.Viewing.Initializer(options, function onInitialized() {
    viewerApp = new Autodesk.Viewing.ViewingApplication('forgeViewer');
    viewerApp.registerViewer(viewerApp.k3D, Autodesk.Viewing.Private.GuiViewer3D);
    viewerApp.loadDocument(documentId, onDocumentLoadSuccess, onDocumentLoadFailure);
  });
}
```

Figure 8 - calling the 3D in BIM 360

By this the web application will bring the 3D model visualization to your application with all the features that BIM 360 Docs have to control the model (sectioning, zoom model properties, etc).

Now you will have to collect the data from the sensors in the building consuming the data from Microsoft Azure IoT Hub, to do this you can use this logic for coding:

```
function triggerPanelUpdate() {
  jQuery.ajax({
    url: 'https://fnhidrometro.azurewebsites.net/api/GetDadosTemp?code=*****',
    dataType: 'json',
    success: function (temps) {
      var record = temps[0];

      _lastRecord = record.Temp;

      _panel.removeAllProperties();
      _panel.addProperty('Temperatura (celsius)', record.Temp, 'Termômetro');

      addCharData(record);

      if (_panel.isVisible()) setTimeout(triggerPanelUpdate, 10 * 1000);
    }
  });
}
```

Figure 9 - calling the sensor data in Microsoft Azure

You will have to point the url where you are storing thing in Microsoft Azure.

This will result in a web application that now can consume the 3D model and also consume the info from Microsoft Azure, you won't be able to see the sensor data unless you manually point equipment per equipment connecting the BIM Model with the Physical world.

The best way to do that is to create a dot above the equipment in the 3D model and connect that dot into the sensor data. To creat the point in the 3D model in the web app you can use the following logic:

```
// Use to capture the points
function onMouseClick(event) {

    var screenPoint = {
        x: event.clientX,
        y: event.clientY
    };

    var n = normalizeCoords(screenPoint);

    var hitTest1 = NOP_VIEWER.impl.hitTest(screenPoint.x, screenPoint.y, true);

    //get hit point
    var hitTest = NOP_VIEWER.utilities.getHitPoint(
        screenPoint.x,
        screenPoint.y);

    if (hitTest1) {
        console.log(hitTest1.intersectPoint);
        drawPushpin({
            x: hitTest1.intersectPoint.x,
            y: hitTest1.intersectPoint.y,
            z: hitTest1.intersectPoint.z
        });
    }
}
```

*Figure 10 - getting the coordinates to create the equipment dot*

The hitTest1 will consume the data of “BRSP430\_403.01\_ZN01\_02F\_04837\_BS05\_SINK01”, it should be something like this:

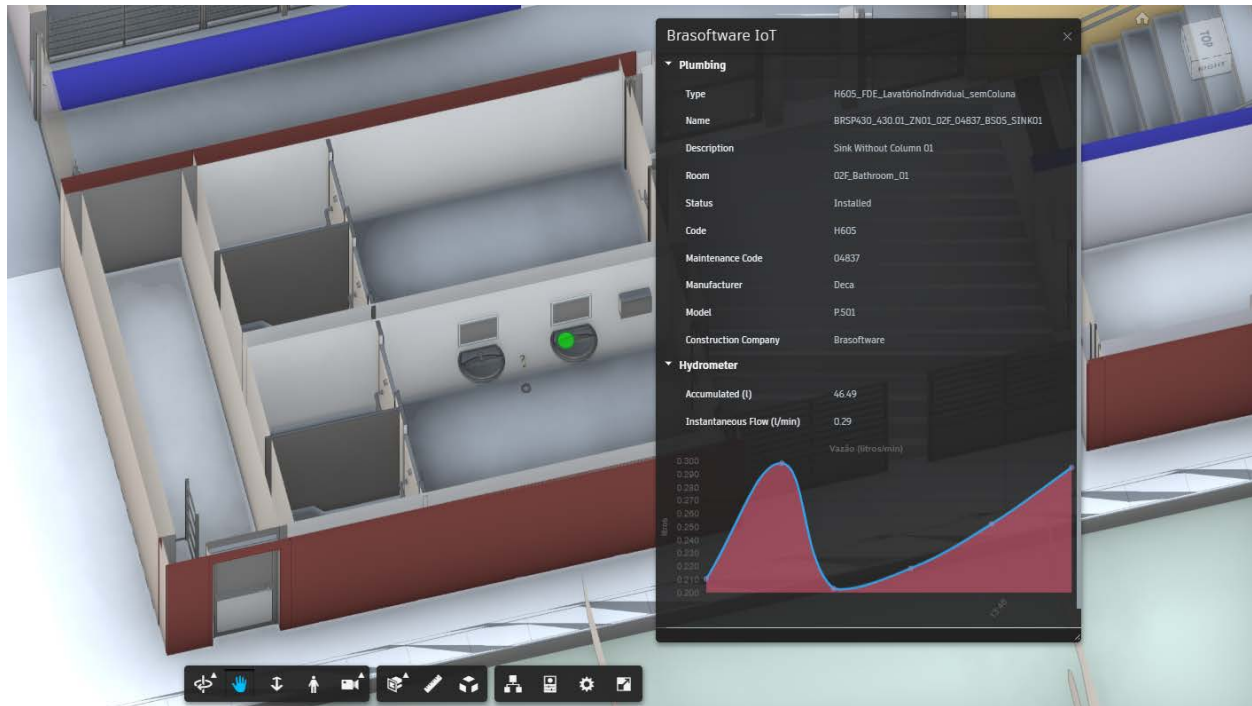


Figure 11 - our digital twin

## How to make predictive analysis from what you are seeing

The first thing you will have to learn from what you are collecting is what do you want to see?

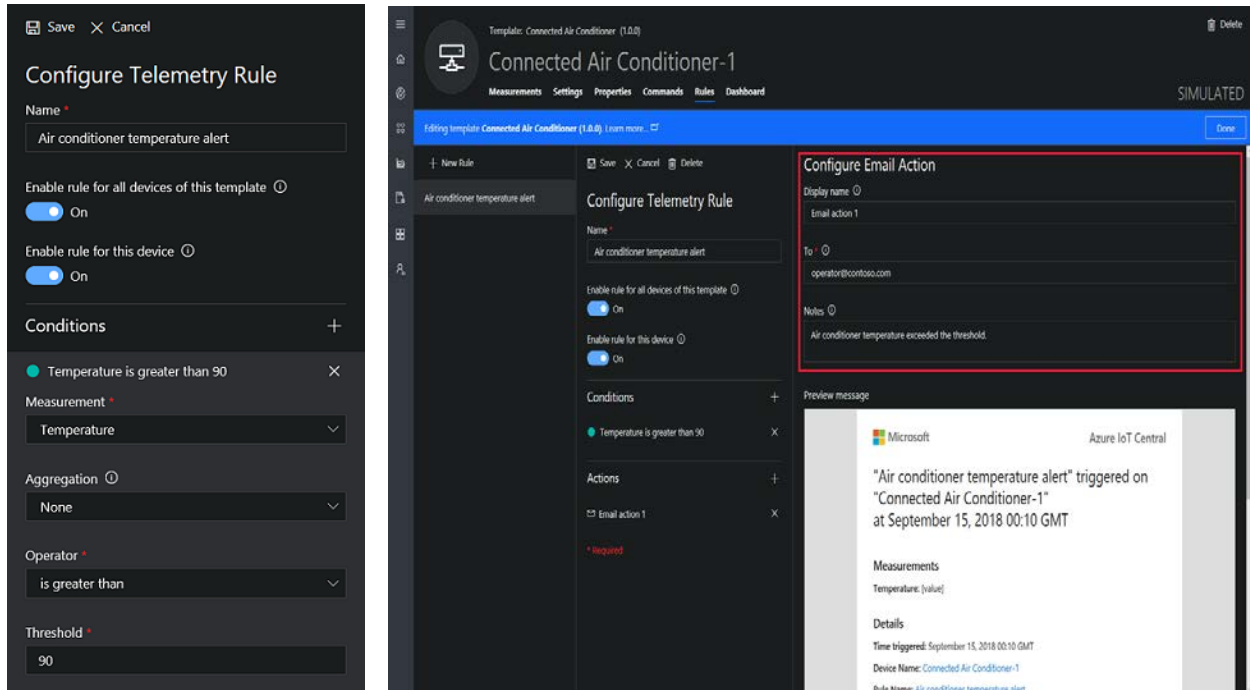
Basically with this technology you can do whatever you want to do and there is one Microsoft Azure guy that I didn't present to you guys that it is the Azure IoT Central, a complete platform that it can used to create the devices, manage the portfolio of devices and most important you can create rules to predictive analysis.

This means that you can learn from the data and create rules to warn your maintenance team if something in the field goes wrong.

Here it is some examples of what Microsoft Azure IoT Central can do:



Figure 12 - Monitoring an Air Conditioner



Save X Cancel

### Configure Telemetry Rule

Name \*

Air conditioner temperature alert

Enable rule for all devices of this template On

Enable rule for this device On

Conditions +

- Temperature is greater than 90

Measurement \*

Temperature

Aggregation None

Operator \*

is greater than

Threshold \*

90

Template: Connected Air Conditioner (1.0.0) Delete

## Connected Air Conditioner-1

**Measurements** Settings Properties Commands Rules Dashboard SIMULATED

Editing template **Connected Air Conditioner (1.0.0)**. [Learn more...](#) Done

+ New Rule Save X Cancel Delete

Air conditioner temperature alert

### Configure Telemetry Rule

Name \*

Air conditioner temperature alert

Enable rule for all devices of this template On

Enable rule for this device On

Conditions +

- Temperature is greater than 90

Actions +

- Email action 1

\* Required

### Configure Email Action

Display name \*

Email action 1

To \*

operator@contoso.com

Notes \*

Air conditioner temperature exceeded the threshold.

Preview message

Microsoft Azure IoT Central

"Air conditioner temperature alert" triggered on "Connected Air Conditioner-1" at September 15, 2018 00:10 GMT

Measurements

Temperature: {value}

Details

Time triggered: September 15, 2018 00:10 GMT

Device Name: Connected Air Conditioner-1

Rule Name: Air conditioner temperature alert

Figure 13 - creating a rule of action to be triggered

You can have much more information on how this can work using the following links:

Create an Azure IoT Central application

<https://docs.microsoft.com/en-us/azure/iot-central/quick-deploy-iot-central>

Define a new device type in your Azure IoT Central application

<https://docs.microsoft.com/en-us/azure/iot-central/tutorial-define-device-type>

Configure rules and actions for your device in Azure IoT Central

<https://docs.microsoft.com/en-us/azure/iot-central/tutorial-configure-rules>

## Conclusion

Making a Digital Twin model is not as hard as the mainstream can think, but what will take time it is to understand the efforts to standardize a process to collect data in the field during the construction phase that will be later used for facility management.

A good way to start is to understand your pain points in operating a building to then understand if that is something that can be, somehow, plugged into an IoT system to start being monitored and bring more intelligence to your process.

Digital Transformation is one step away and all that we need to start changing the future of construction is have the courage to innovate and knowing the technologies that are available nowadays.

We can discuss the future of construction and we are open to hear what you guys think about this technology, you have my contacts from this lecture, just enter in contact with me that will be a pleasure to help.

## References

Mapping the Information Economy: A Tale of Five Industries

<https://blog.box.com/mapping-the-information-economy-a-tale-of-five-industries>

Gartner Top 10 Trends for 2017

<https://www.gartner.com/smarterwithgartner/gartners-top-10-technology-trends-2017/>

BU18239: Useless or Priceless? How to Prepare and Use a BIM Model for FM and Building Ops.

<http://au.autodesk.com/au-online/classes-on-demand/class-catalog/2016/building-ops/bu18239/jcr:content>

Autodesk Forge: Getting Started

<https://autodesk-forge.github.io/?GettingStarted>

Types of sensors

<http://securitytagsuganda.com/wireless-sensors/>