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Digital Twin – Tutorial

Digital Twin

- A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process.

WIKIPEDIA
The Free Encyclopedia

- In the world of buildings, a digital twin is a replica of a space or building, containing several kinds of information that is gathered from IoT devices, the building's automation system, and/or the users of the building.

Dr. Ken Dooley, I'm tired of waiting for the perfect digital twin

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Smart city

- **Smart city** is a concept that integrates various data sources and city infrastructure together and provides different views, operations, and services to citizens

- **Smart Building** is one of the building blocks of **Smart City**

Digital Twin

- You can't have **Smart building** unless you can:
  - Collect, store, combine, analyze, visualize, etc. data
- You also need to see dependencies of data

- Digital Twin gathers all types of data together
- Digital Twin enables model based what-if-analysis
- Digital Twin offers Aspect of Objects i.e. different views for different users (from same data)

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Types of Digital Twins (1/2)

- **As-built**
  - Architectural, structural and building services models from design and construction to in-use and demolition/recycling

- **Building Services**
  - Components relevant to long term optimization of the buildings' technical systems
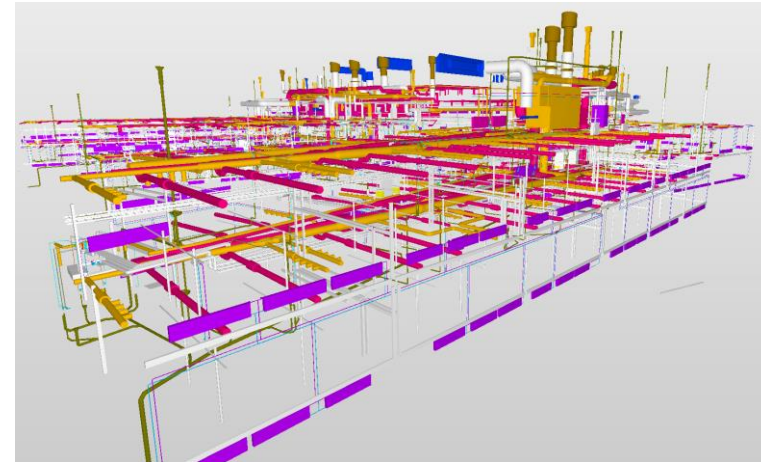
https://issuu.com/granlundoy/docs/building_digital_twins

Types of Digital Twins (2/2)

- ## Interactive Floorplan
  - 2D floor planning visualizing static and dynamic data

- ## Business Intelligence Dashboard
  - 2D map or floorplan together with business data

https://issuu.com/granlundoy/docs/building_digital_twins
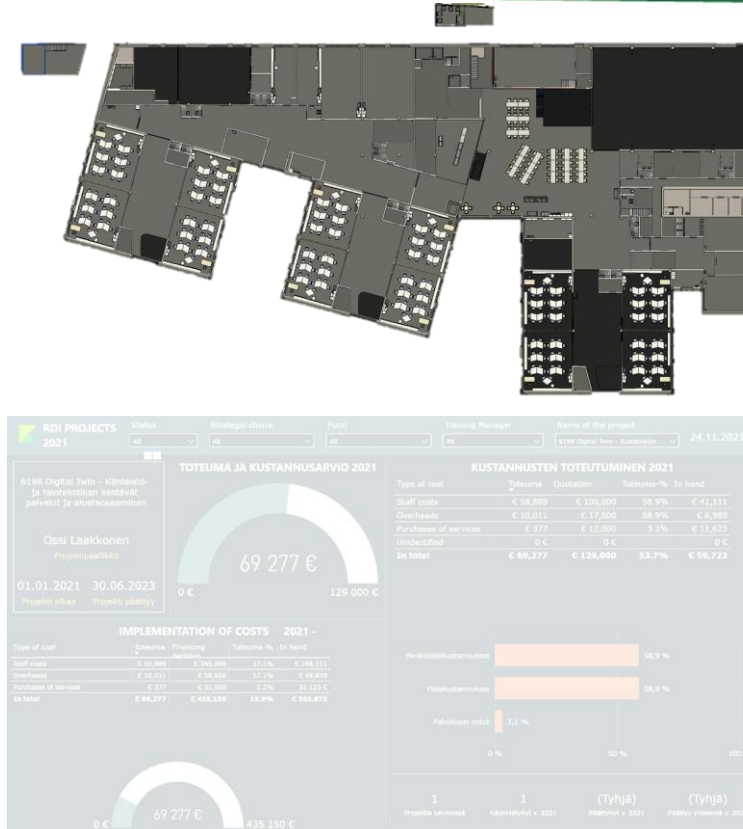
Static data

- BIM
  - Architecture
  - Structure
  - Components
  - Materials
  - Devices
  - …

- User manuals
- Warranty certificates
- Construction site documentation
- …

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Dynamic data

- Environmental conditions
- Consumptions
- Statuses
- People behaviour
- Costs

- Energy production
  - Solar panels
  - Soler collectors
  - Condense energy
  - Ground energy

Tens of thousands, sometimes even hundreds of thousands of data points

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Getting Data

Automation

- T, RH%, Pdiff, CO_2, TVOC
- Water (m^3)
- Electricity (kWh)
- Distributed energy (MWh)
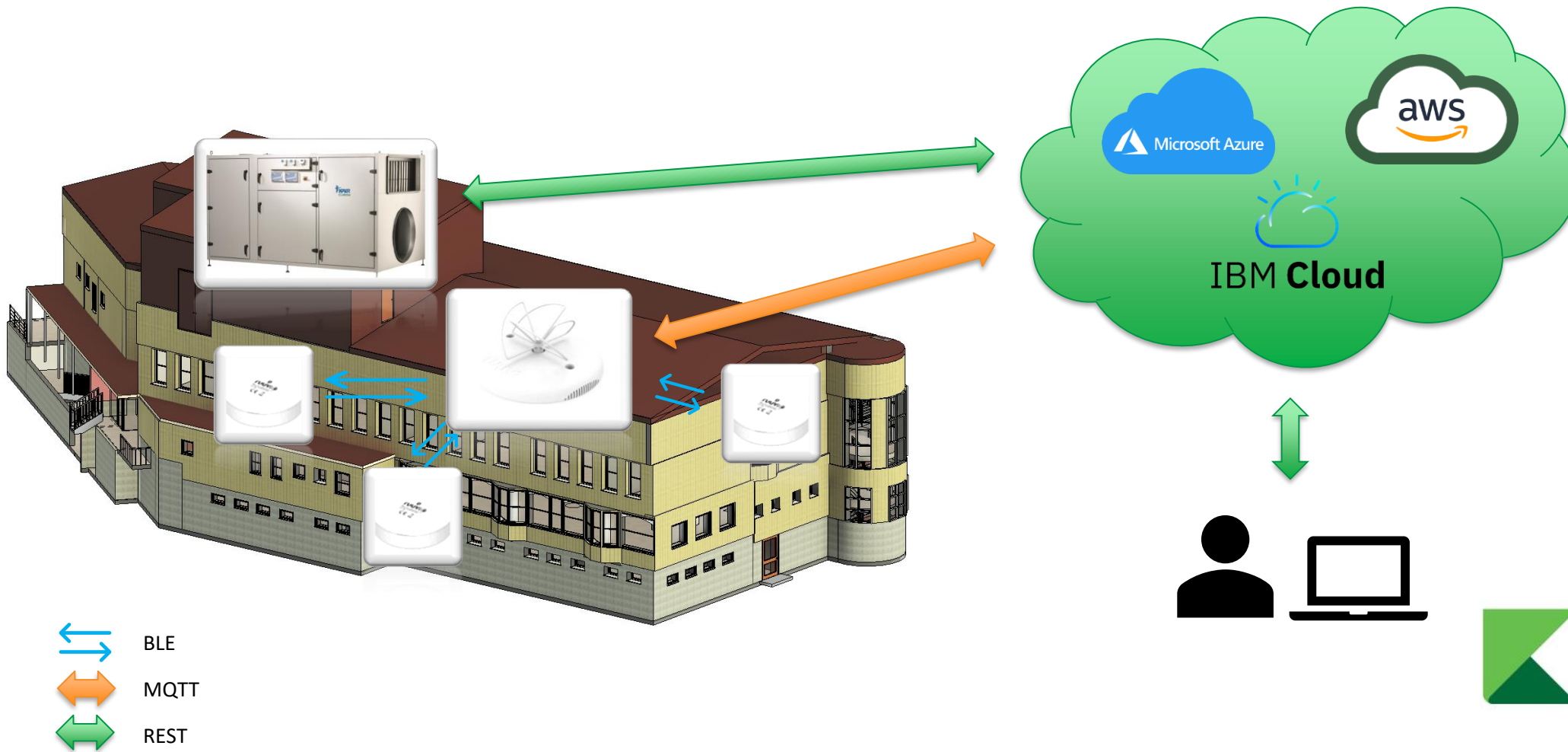- Condense Energy (MWh)
- Air flow, channel pressure

IoT

- T, RH%, P, CO_2, TVOC
- Vibration, motion
- Presense/person count
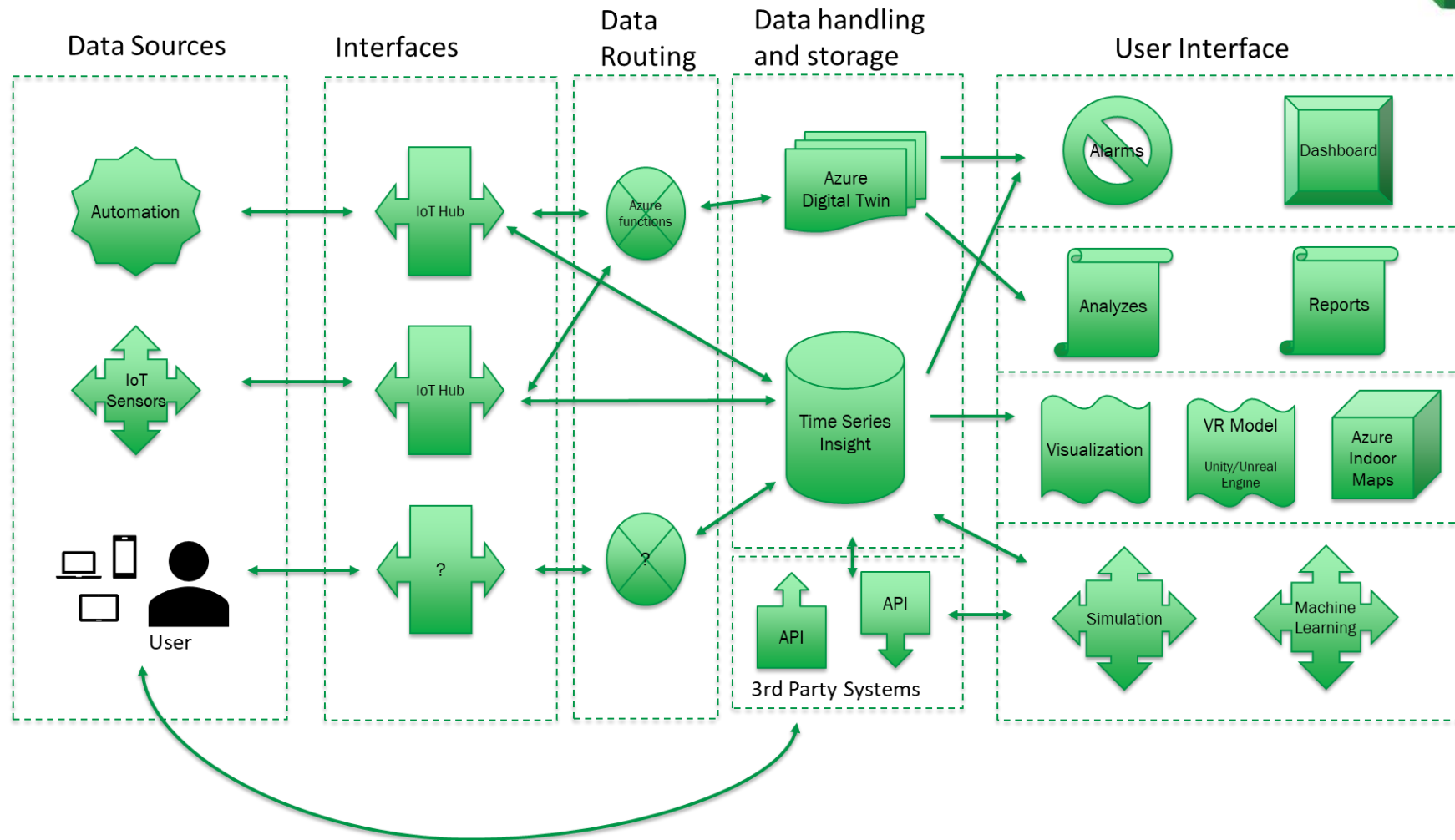- Air quality
- Light intensity/color
- Acceleration/Shock

Users

- Feedback/User Experience
- Reservation
- Service request

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System Architecture

BLE
MQTT
REST

Cloud Architecture

Data Sources

Interfaces

Data Routing

Data handling and storage

User Interface

Automation

IoT Sensors

User

IoT Hub

IoT Hub

?

Azure functions

?

Azure Digital Twin

Time Series Insight

API

API

3rd Party Systems

Alarms

Dashboard

Analyzes

Reports

Visualization

VR Model
Unity/Unreal Engine

Azure Indoor Maps

Simulation

Machine Learning

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API – Application Programming Interface

- An **application programming interface** (API) is a connection between computers or between computer programs. It is a type of software interface, offering a service to other pieces of software.

WIKIPEDIA
The Free Encyclopedia

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Database

- A **database** is an organized collection of data stored and accessed electronically from a computer system

- A **time series database** (TSDB) is a software system that is optimized for storing and serving time series through associated pairs of time(s) and value(s)

What Digital Twin offers

- Carbon footprint
- Carbon handprint
- Energy certification
- Ecosystem
- Troubleshooting

- Employee experiense
- Safety
- Space management
- Facility management
- Predictive maintenance

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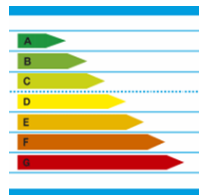
Digital Twin

Challenges or strategic opportunities

Single source of truth

One single source for multiple lifecycle applications – reduce lifecycle costs and time to market

Unified access

To devices and data in the building

Visualization

of actual building structures and rented out spaces across the building lifecycle

Scalable ecosystem

that allows you to deliver your services in the most costefficient way

Quality

Machine readable data, automated quality checks and processes

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Construction validation

https://new.siemens.com/global/en/products/buildings/digital-building-lifecycle/building-twin.html
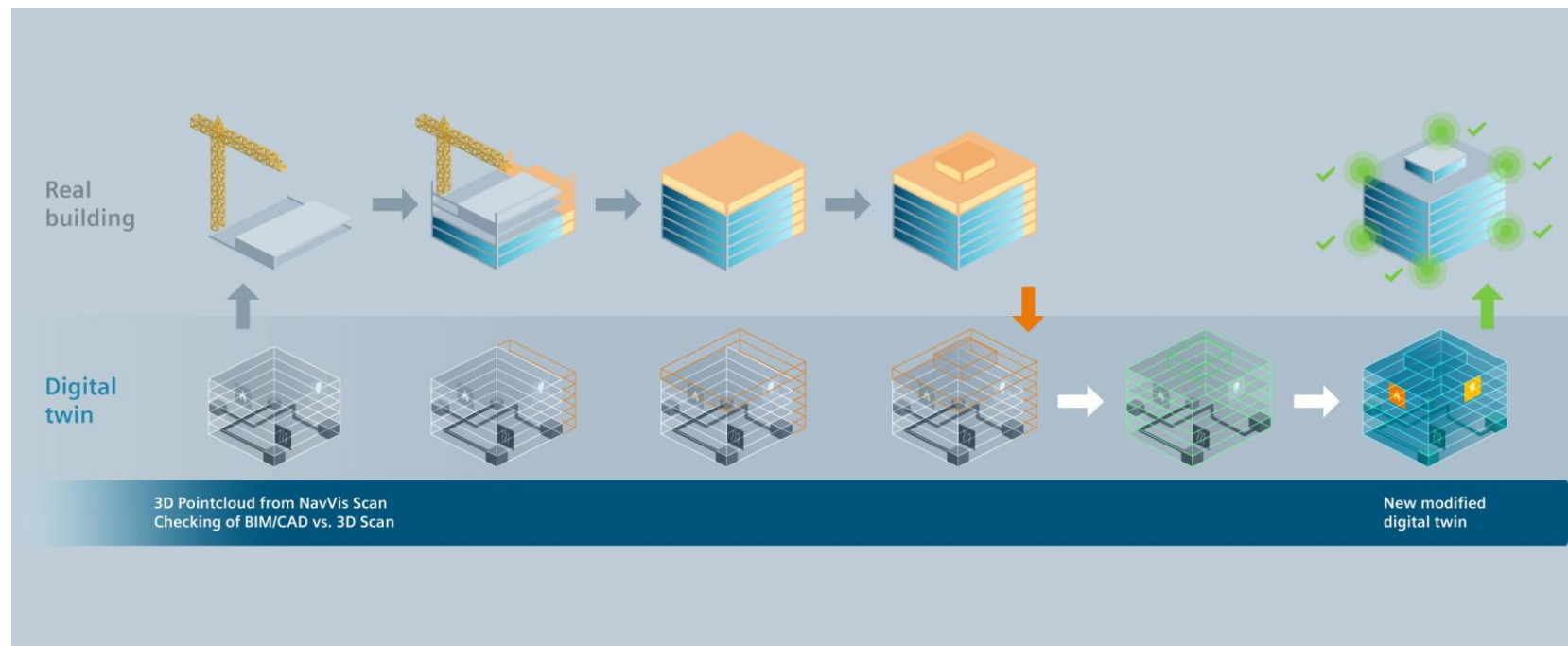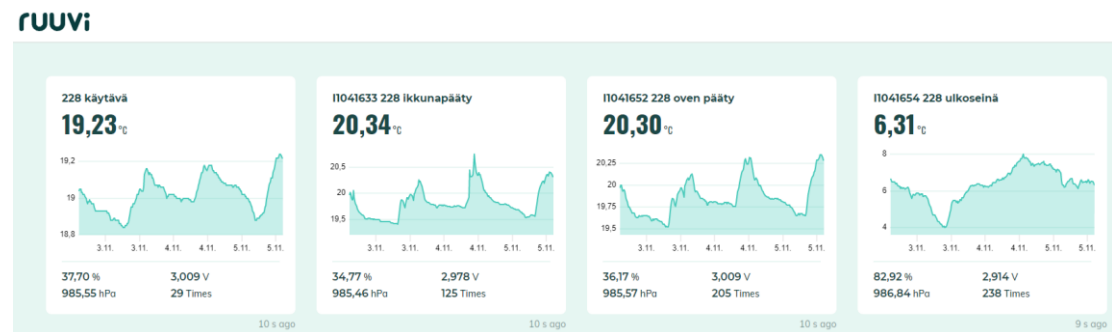
Visualization

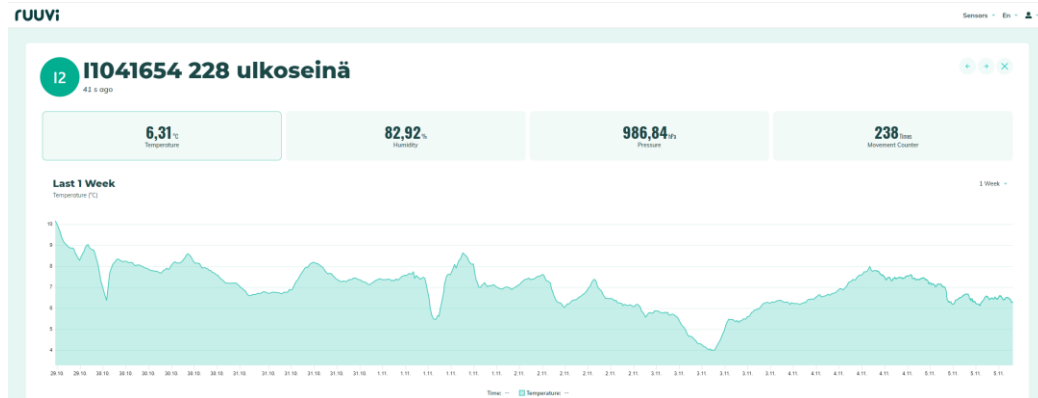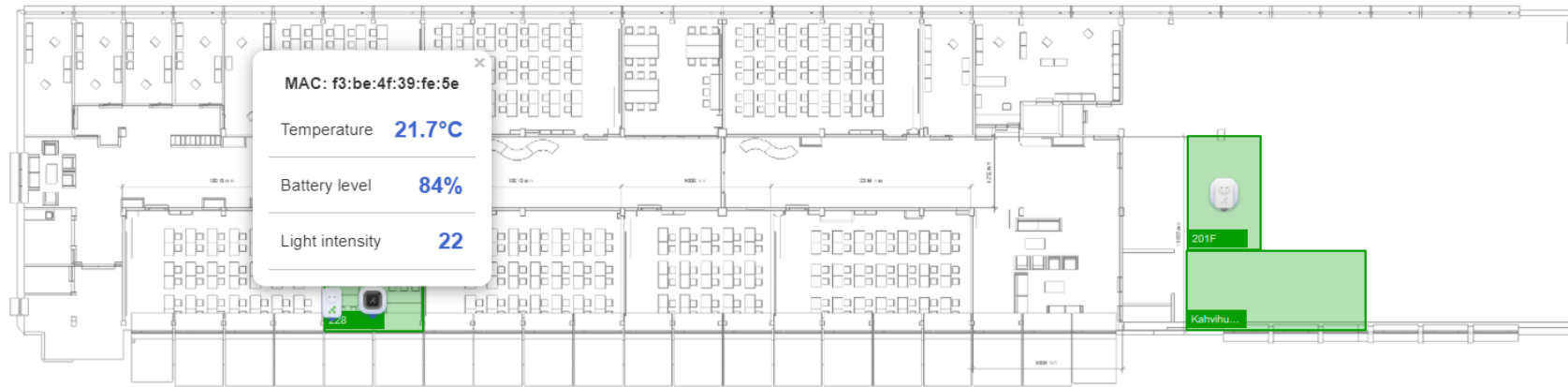- Technique for creating images, diagrams, or animations to communicate a message
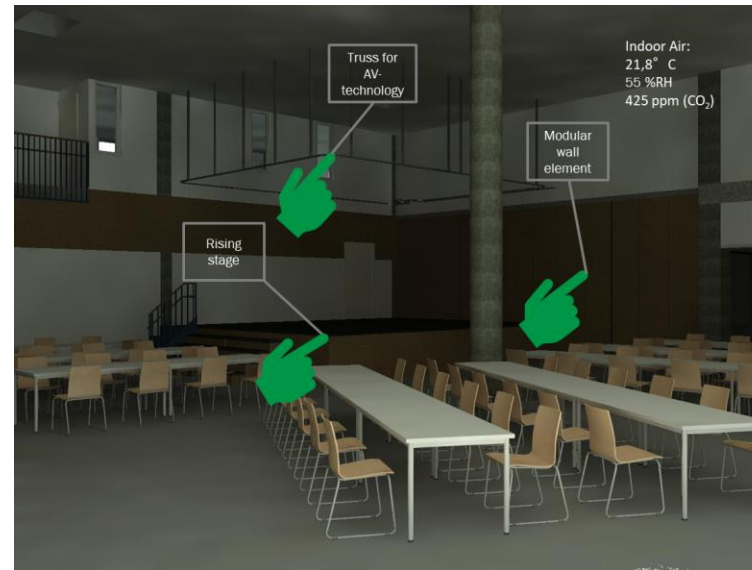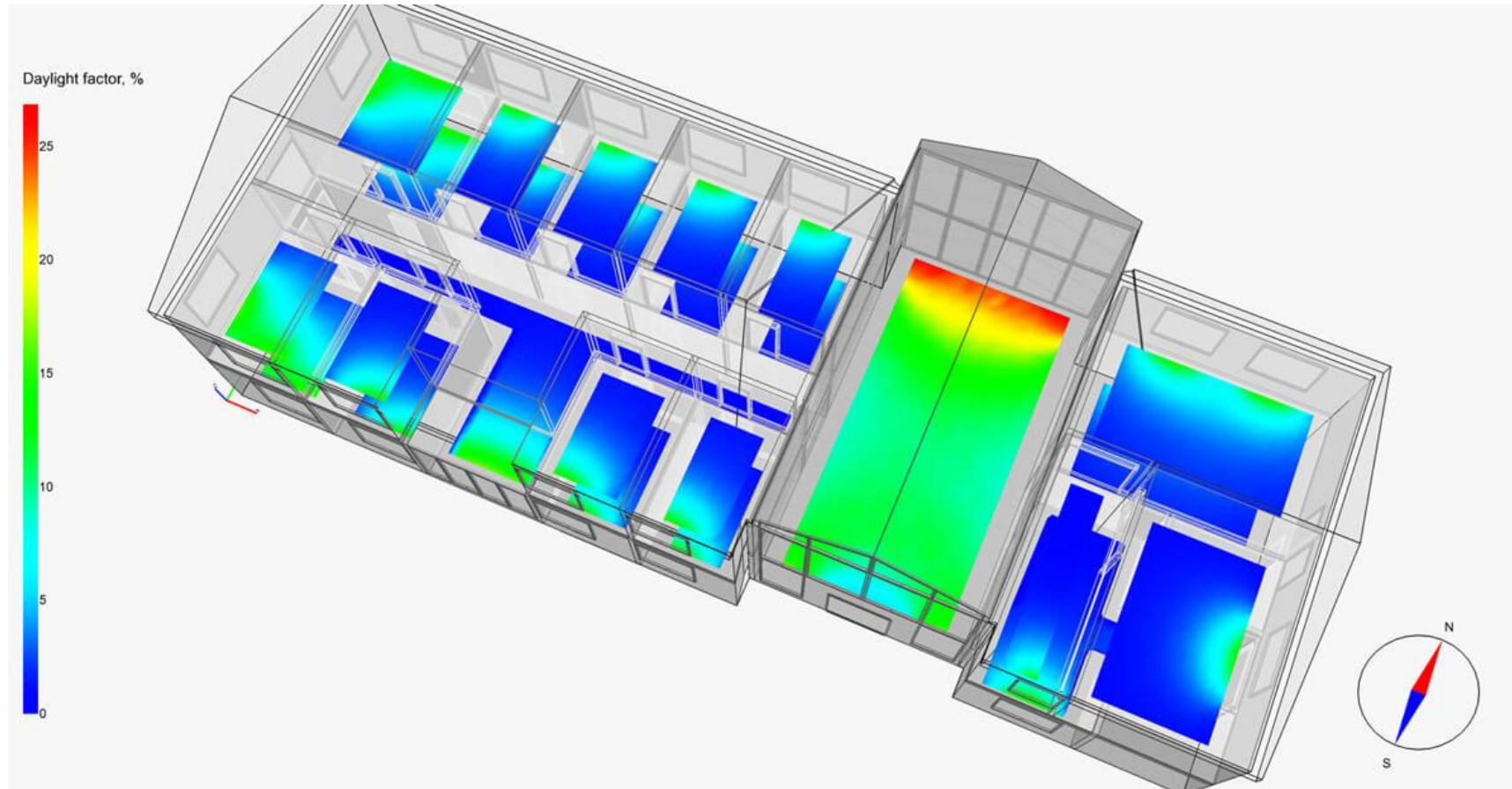
Visualization

Simulation

Analysis

3. Building automation starts to correct situation

2. Air humidity starts to rise rapidly

1. Room pressure starts to drop

4. Room temperature drops rapidly
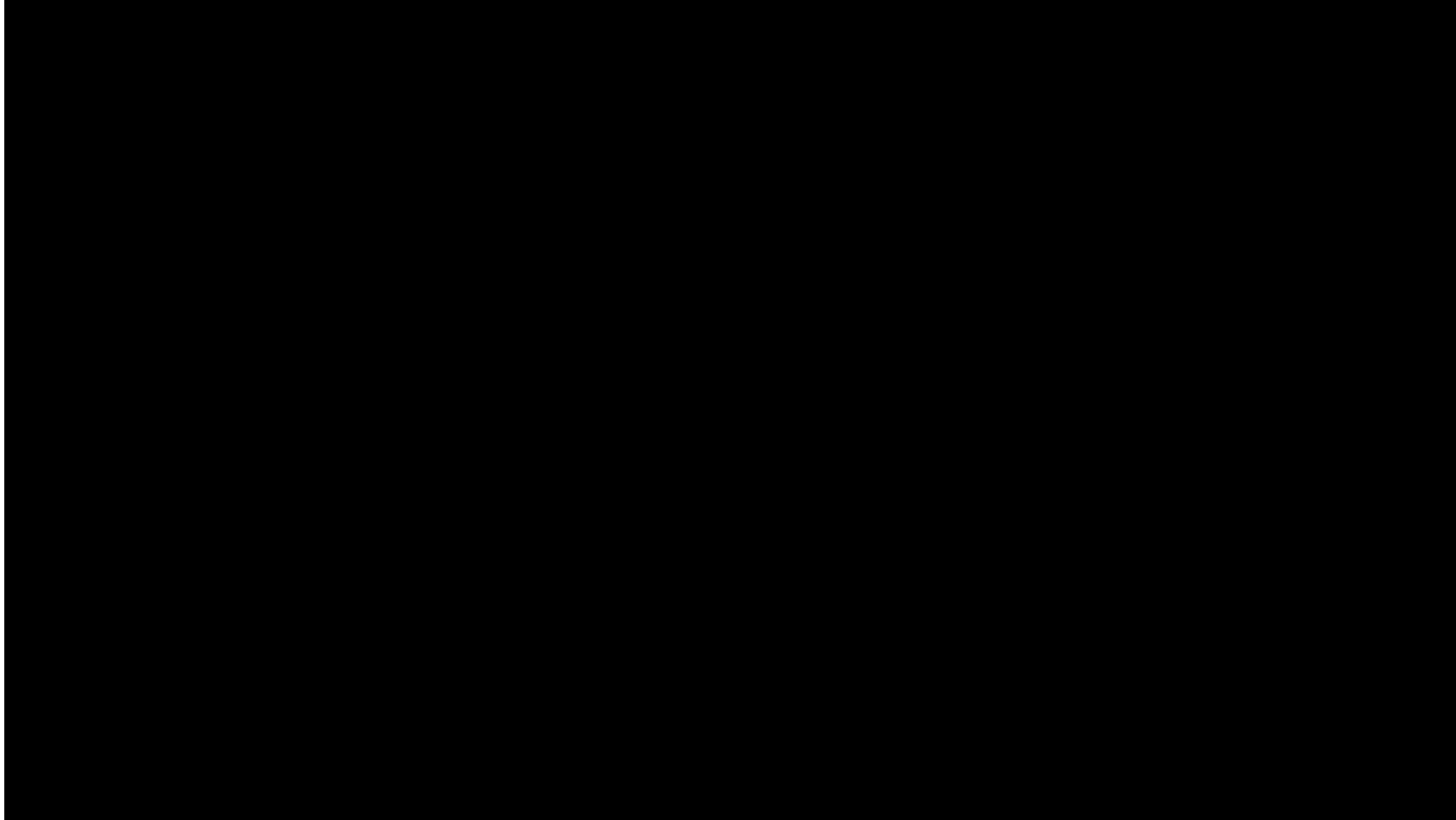
5. Room humidity within limits

6. Room temperature within limits

Gamification

Digital Twin Example

https://www.youtube.com/watch?v=cexMerL1MG8

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More information

- What is building information modeling
- BIM, digital twin and standardized information
- What is the Digital Twin?
- What is the digital lifecycle?
- Collecting data – not as easy as it sounds
- Showdown: 2D versus 3D
- BIM through the planning and design phase
- Connecting and collecting data
- BIM through the construction phase
- Leveraging BIM in the operation phase
- Keeping the Digital Twin up to date
- BIM BAM BOOM
- Use cases for the Digital Twin
- What is the future for BIM?

- Digital Twin enabling the future
- Leveraging the digital twin with data analytics
- Building communication protocols and cyber security
- What does "smart" mean?
- Different levels of BIM database
- Data Visualization
- Visualisation of the Digital Twin

Thank you !

Let's craft a better tomorrow. Together.

Centre for Economic Development, Transport and the Environment

Leverage from the EU 2014–2020

European Union
European Social Fund