Tishk International University
Science Faculty
IT Department

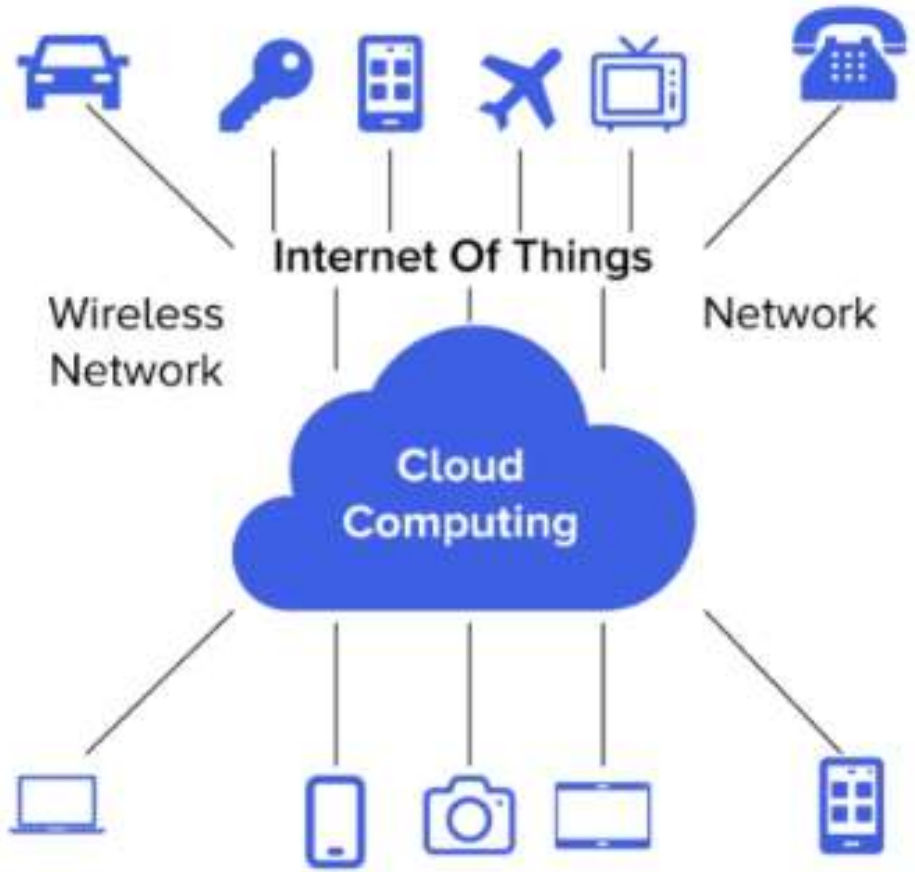
Introduction to IoT

Lecture 04: Cloud of Things

4th Grade - Spring Semester

Instructor: Alaa Ghazi

Lecture 4
Cloud of Things



Lecture Topics

- ❑ Introduction to Cloud Computing in IoT
- ❑ Benefits of IoT Cloud
- ❑ ThingsBoard IoT Cloud Platform
- ❑ MQTT Protocol with ThingsBoard
- ❑ ThingsBoard System Architecture
- ❑ ThingsBoard Visualization Options
- ❑ ThingsBoard Rule Engine
- ❑ ThingsBoard Widget Types
- ❑ Configuration Tutorial:
  - Step 1. Provision Device
  - Step 2. Checking Device Connectivity
  - Step 3. Create an Empty Dashboard
  - Step 4: Add Table & Chart Widgets

Introduction to Cloud Computing in IoT

- Cloud computing enables users to perform computing tasks using services provided over the Internet.
- The IoT and cloud computing are now interrelated technologies.
- Cloud computing helps in storing, processing, and accessing large amounts of IoT data.
- As an example, sensor data can be uploaded and saved using cloud computing for later use as intelligent monitoring.

Benefits of IoT Cloud

1. It provides many connectivity options,
2. It can be used and scaled on-demand,
3. It increases collaboration between users, and
4. It provides reliable authentication and encryption protocols.

ThingsBoard IoT Cloud Platform

- **ThingsBoard** is an open-source IoT platform for data collection, processing, visualization, and device management.
- **Open-Source Advantage:** allows customization, and community support.
- **ThingsBoard Core Functionalities:**
  - **Device Management and Data Collection:** ThingsBoard can handle a large number of devices and high data volumes, ensuring robust performance for critical IoT deployments at all times.
  - **Data Visualization:** Users can create custom dashboards to visualize data, monitor device performance, and gain insights from IoT data streams.
  - **Data Processing and Alerting:** The rule engine enables automated responses to specific events, integrating seamlessly with other systems for automated IoT operations.

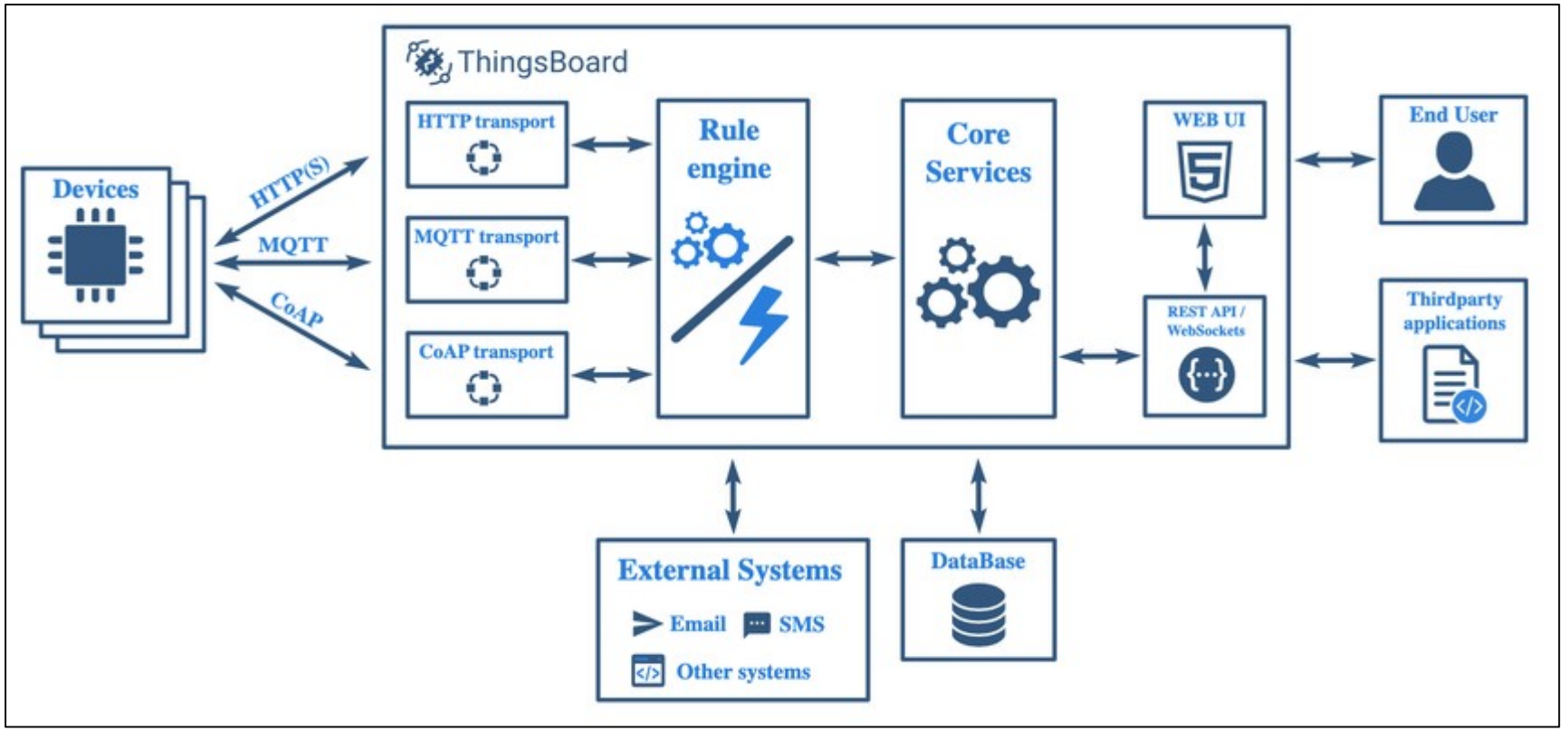
MQTT Protocol with ThingsBoard

- MQTT is lightweight and suitable for devices with low bandwidth.
- MQTT uses a publish-subscribe model.
- MQTT supports TLS/SSL encryption.
- MQTT ensures reliable message delivery with QoS levels.

ThingsBoard System Architecture

- **Device Connectivity:** Devices use MQTT to send data to a cloud-based MQTT broker, acting as a gateway for data injection into the ThingsBoard platform.
- **Data Breakdown and Processing:** ThingsBoard processes data via a rule engine, and stores it for analysis and visualization.
- **Cloud Infrastructure:** The entire system is hosted on a cloud infrastructure, providing scalability, reliability, and global accessibility for IoT solutions.
- **User Interface and Dashboards:** Users interact with the system through ThingsBoard's Web User Interface.

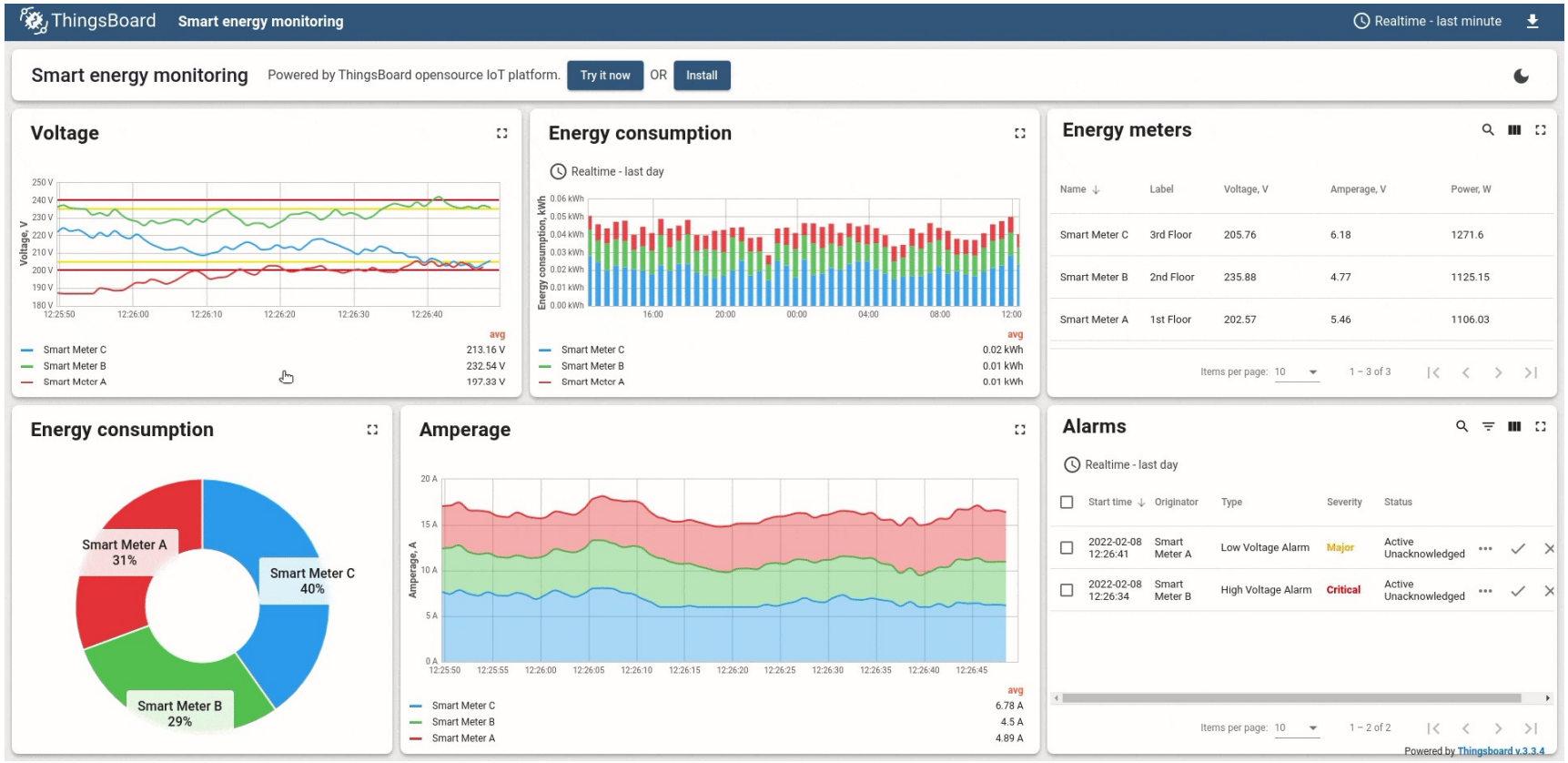
ThingsBoard Architecture Diagram



ThingsBoard Visualization Options

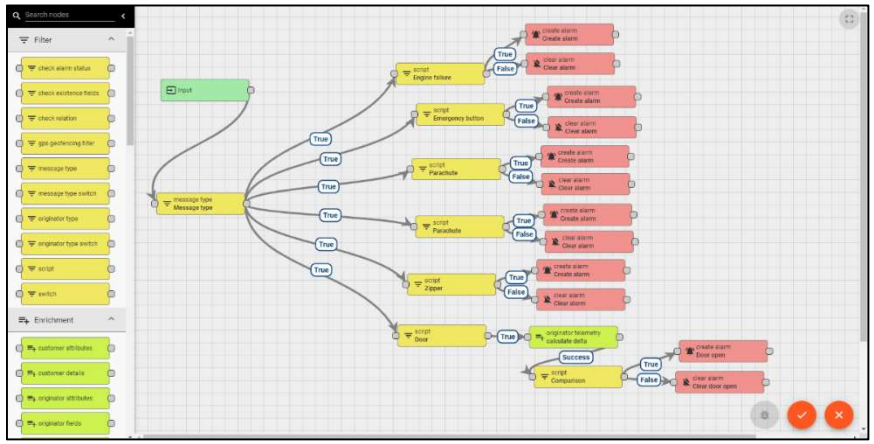
1. **Real-Time Monitoring:** Use real-time widgets to monitor live data streams, providing instant feedback on device performance and environmental conditions from the environment.
2. **Historical Data Analysis:** Analyze historical data to identify trends, patterns, and anomalies, enabling predictive maintenance and optimized operations over time.
3. **Alerting and Notifications:** Set up alerts and notifications based on data thresholds, ensuring timely responses to critical events and potential issues on the go.

ThingsBoard Visualization Options Demo



ThingsBoard Rule Engine

- **ThingsBoard Rule Engine:** is the core processing engine responsible for executing logic on incoming data (telemetry, attributes, events) from IoT devices. It manages how data flows and determines what automated actions should be taken based on predefined logic.
- **ThingsBoard Rule Chains:** are visual workflow or sequence of logic blocks (called nodes) that define how the Rule Engine should process incoming data. Each Rule Chain is made up of multiple rules and actions, enabling automated responses to pre-defined events and triggers at once.
- Rule Chains are essentially the **programs/scripts** that the Rule Engine interprets and runs.

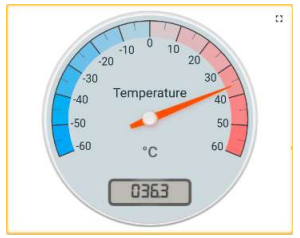


ThingsBoard Rule Chain Actions

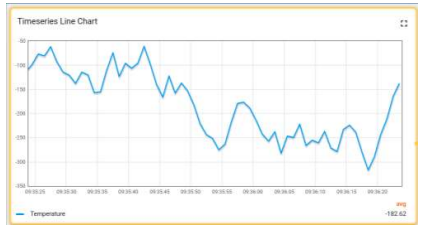
1. **Filtering Data:** Filter data based on specific criteria, such as thresholds, device types, or geographic locations.
2. **Transforming Data:** into different formats or units for compatibility with other systems or to perform calculations and aggregations.
3. **Triggering Actions:** such as sending alerts, updating device attributes, or invoking external APIs.
4. **Integration with External Systems:** such as databases, email servers, or SMS gateways, to enhance automation.

ThingsBoard Widget Types

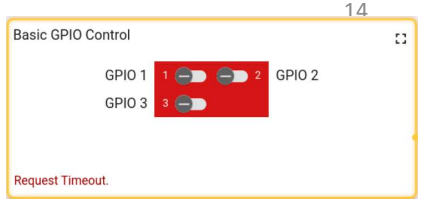
1. **Latest values:** is designed to showcase the latest values of a specific entity attribute or time series data point (e.g., any Gauge Widget or Entities Table widget).



2. **Time series:** displays historical values for the selected period of time, or the latest values in the certain time window (e.g., Timeseries Line Chart or Timeseries Bar Chart).

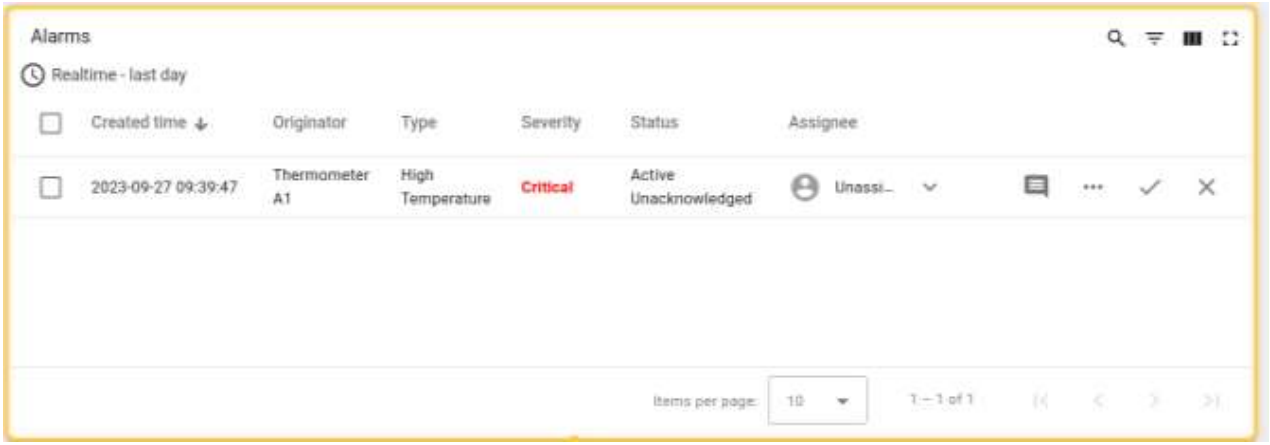


3. **Control widget:** allows sending RPC commands to devices, it handles and visualizes replies from the device (e.g., Raspberry Pi GPIO Control).

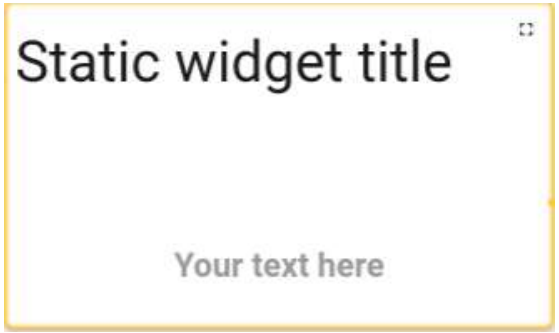


ThingsBoard Widget Types

4. **Alarm Widget:** displays alarms related to the specified entity in the certain time window (e.g., Alarms table).



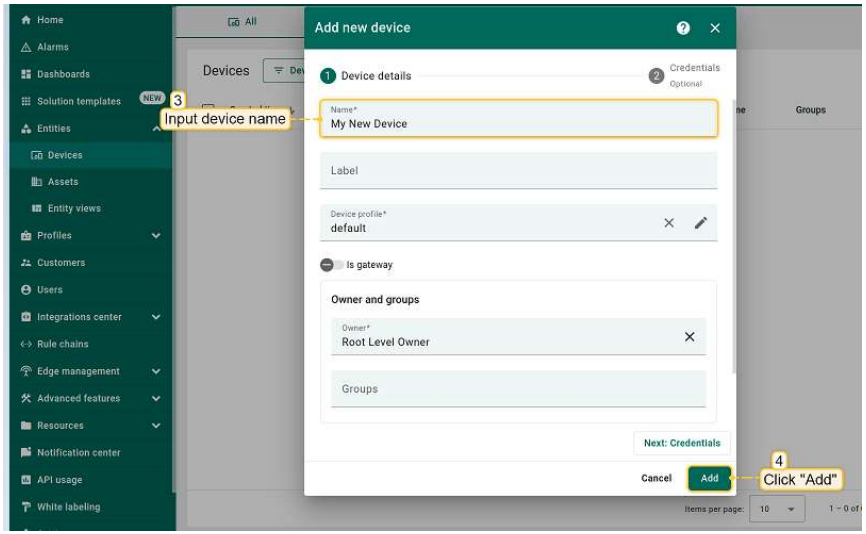
5. **Static:** displays static customizable HTML content (e.g., HTML card). Static widgets don't use any data sources and are usually configured by specifying static HTML content and, optionally, CSS styles.



Configuration Tutorial
Step 1. Provision Device

To add a new device, follow these steps:

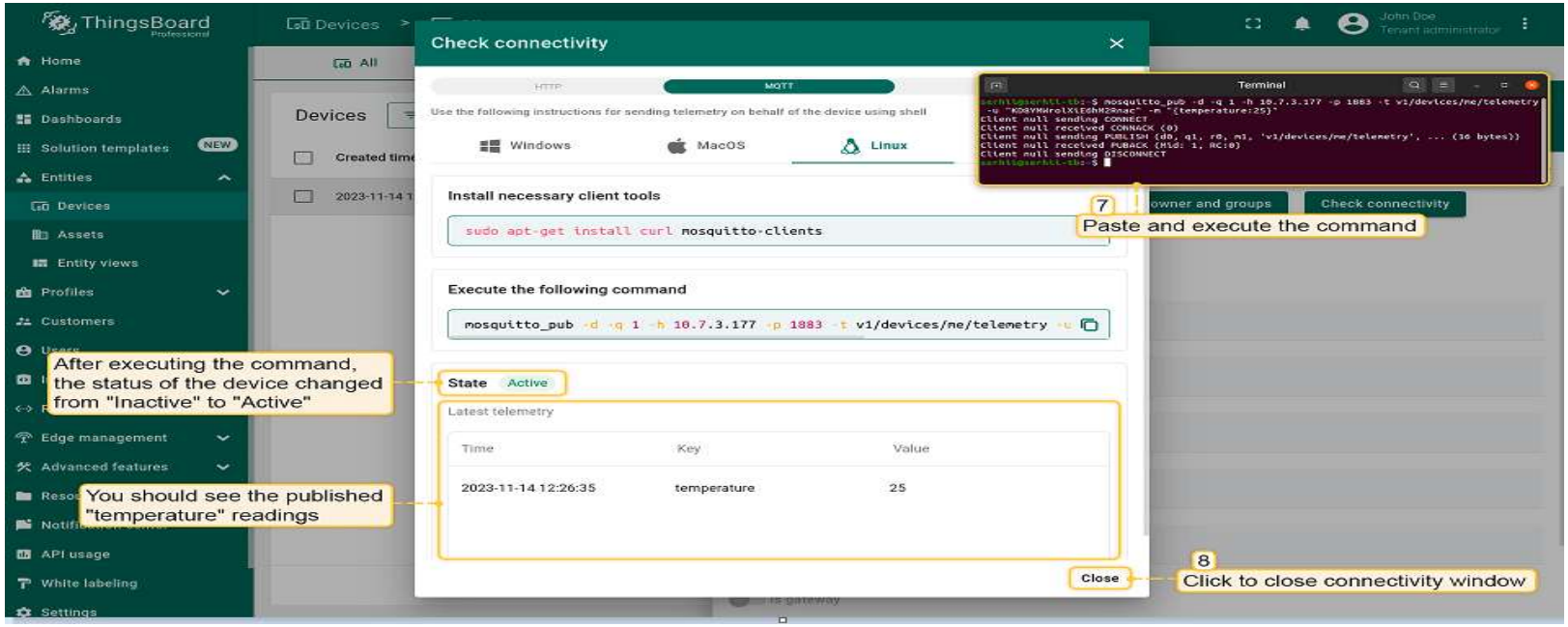
- Go to the "Devices" page of the "Entities" section;
- Click on the "+" icon in the top right corner of the table
- Select "Add new device" from drop-down menu;
- Enter the device name. For example, "My New Device". No other changes required at this time. Click "Add";
- A window will open where you can check the device's connection to ThingsBoard.



Step 2. Checking Device Connectivity

Using the “Check connectivity” functionality to publish telemetry data from the standard host on behalf of the device:

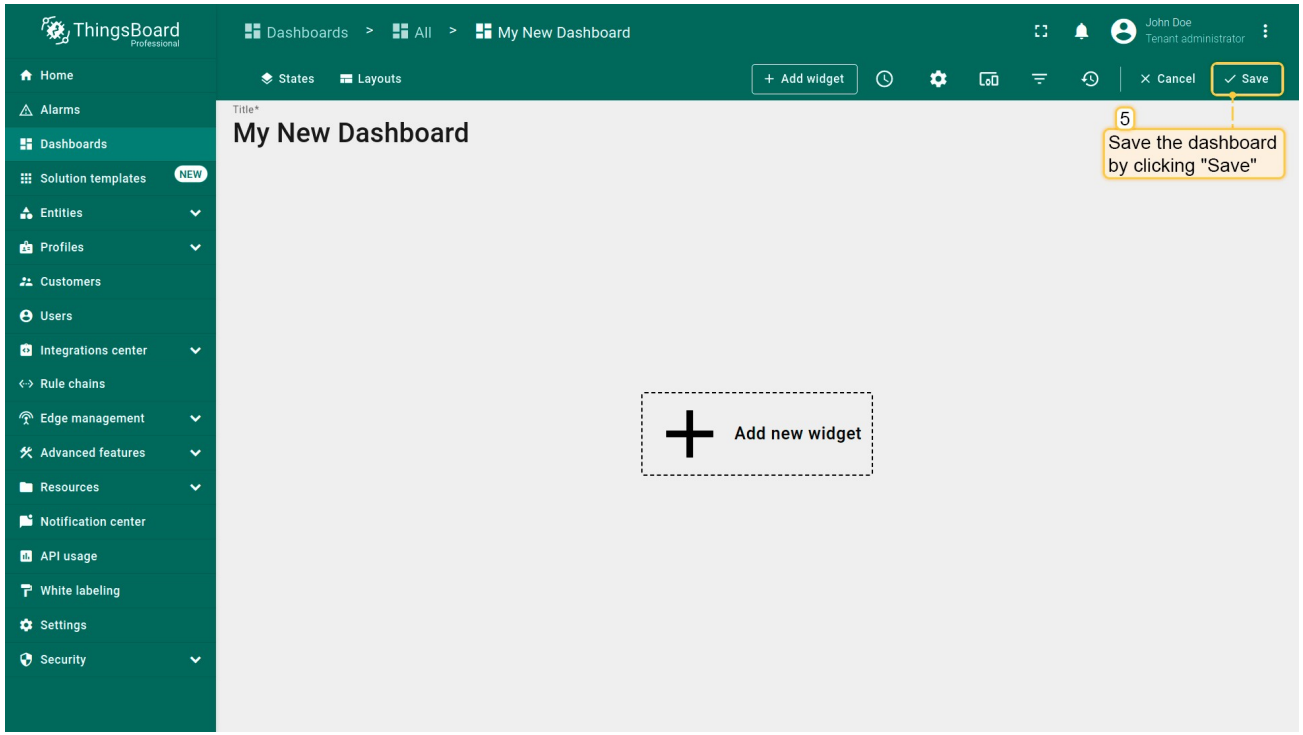
- Click the "Check connectivity” button in the "Device details" window;
- Select the messaging protocol and operating system.
- Install the necessary client tools and copy the command;
- Execute the command in the standard host.
- Once the device published the readings, the device state will change from "Inactive" to "Active" and you should see the published readings.



Step 3. Create an Empty Dashboard

A **Dashboard** in ThingsBoard allows users to visualize and monitor data collected from IoT devices. To create a new dashboard, follow these steps:

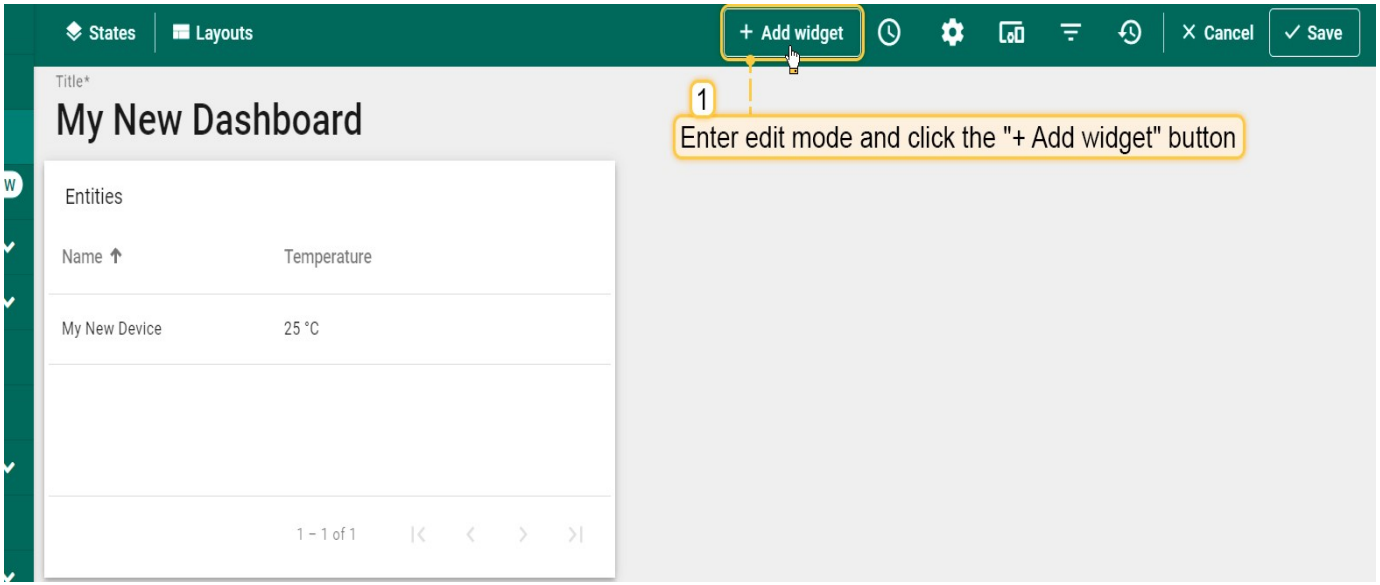
- Go to "Dashboards" → "+" → "Create new dashboard", enter a title, and click "Add". Then add widgets and click "Save".



Step 4: Add Widgets

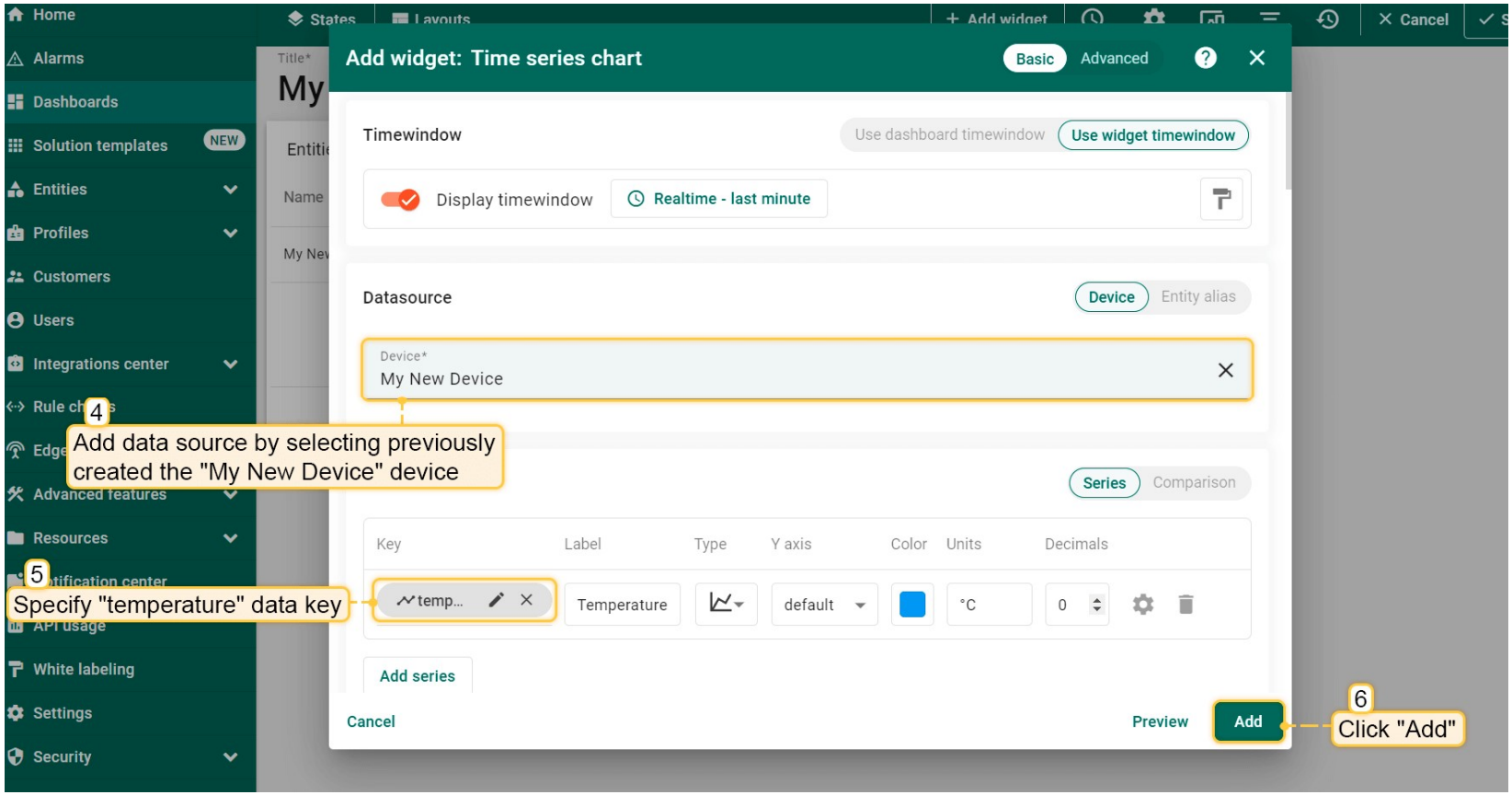
To add a new widget, follow these steps:

- In dashboard “Edit Mode”, to quickly find your desired widget, use the search bar.
- click "Add widget" , then to quickly find the desired widget, use the search bar.
- Choose the suitable widget from the widget library.
- Select the device (e.g., My New Device), add "name" and the data keys, and click "Add", then "Save".



ThingsBoard Web UI
Widgets Library

Widget Configuration



ThingsBoard Dashboard Example