第四讲
ThingsBoard（I）
Lecture 4
ThingsBoard (I)

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声明
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ThingsBoard安装
ThingsBoard Installation

- ThingsBoard是一个用于数据收集、处理、可视化和设备管理的开源物联网平台。由于其开源属性，ThingsBoard在许多场合广为应用，其中不乏工业场景。因此，我们可以合理地假设ThingsBoard具备一定的工业强度，这意味着在一般的实验室应用中即使部署在本地，完全能支撑相关开发、测试的开展。而ThingsBoard由于其开源属性，在基于Linux的平台上安装部署十分方便，但考虑到Windows的易用性，特别是在教育领域，因此本讲主要介绍在Windows平台上的安装。

ThingsBoard is an open-source IoT platform for data collection, processing, visualization, and device management. Due to its open source characteristics, ThingsBoard is deployed in many applications, including industrial scenarios. Therefore, we can assume its industrial strength and capabilities to support development and testing even deployed locally. Usually, Linux platform comes with the innate advantage to run open source software, however, considering the user-friendliness of Windows, especially for education, this lecture emphasizes the installation on Windows.
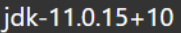
ThingsBoard安装
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▶ 首先，ThingsBoard的核心服务是基于Java开发的，因此需要安装Java开发包（Jave Development Kit或JDK），我们选择开源的Eclipse Temurin™实现，可以从下面网站下载安装：https://adoptium.net/temurin/releases/。我们在打开的页面内，设置适配的条件，网站会将符合条件的JDK软件包列出，供我们下载。

First of all, the core services of ThingsBoard are developed using Java, so the Java development kit (JDK) needs to be installed. We choose the open-sourced Eclipse Temurin™ implementation, which can be downloaded and installed from the following website: https://adoptium.net/temurin/releases/. On the webpage, we set the filter and the website will list the JDK packages that meet the conditions for us to download.

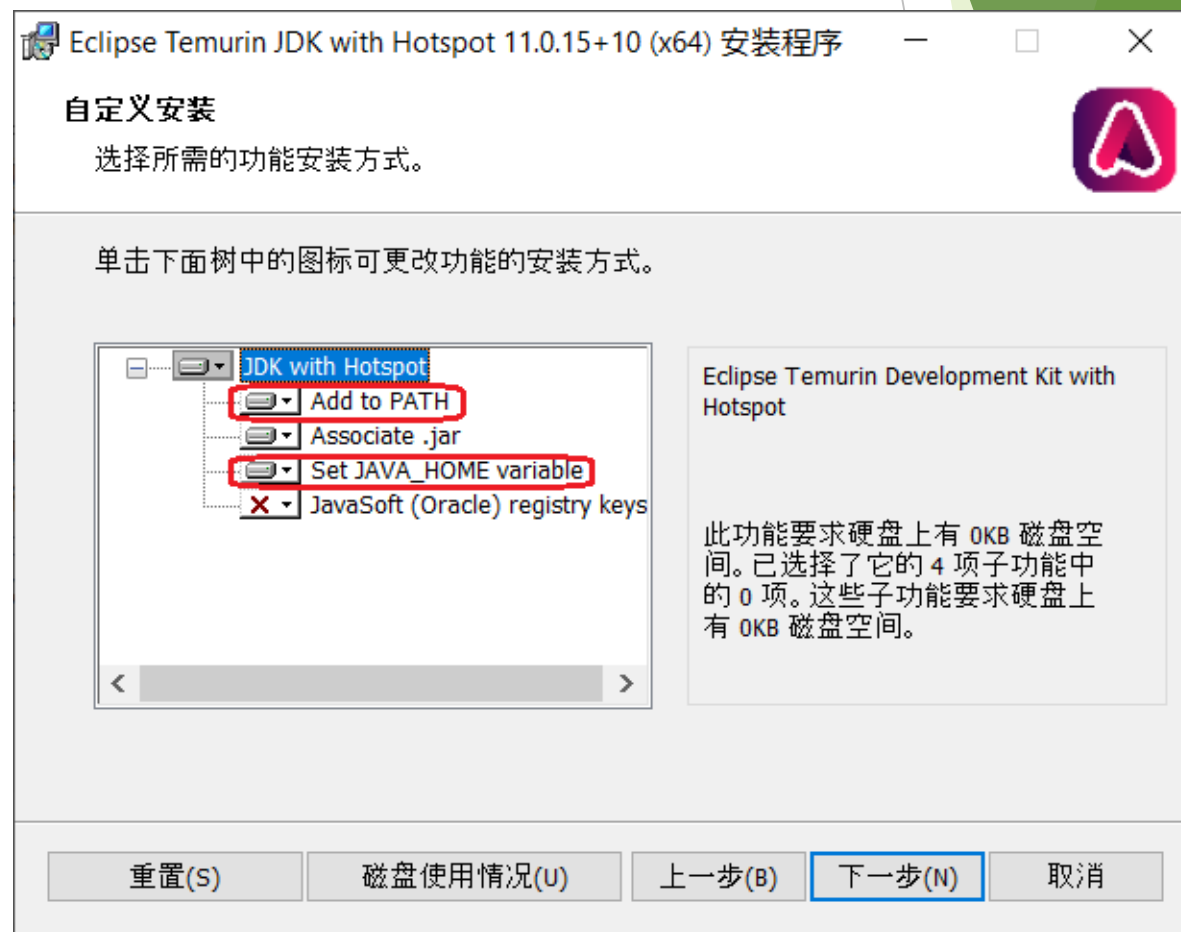| Operating System	Architecture	Package Type	Version
Windows	x64	JDK	11

jdk-11.0.15+10 Temurin 25 April 2022	Windows	x64	JDK - 175 MB checksum	.msi
			JDK - 196 MB checksum	.zip

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▶ 当将MSI包下载下来之后点击安装时，可以选择默认安装，也可以选择自定义安装。选择自定义安装时，要保证"Add To Path"选项以及"Set JAVA_HOME variable"选项不被反选（这两项默认是勾选的）。

After downloading the MSI package, one can choose a default installation or a customized installation. When choosing a customized installation, make sure that the "Add To Path" option and the "Set JAVA_HOME variable" option are not de-selected (these two are checked by default).
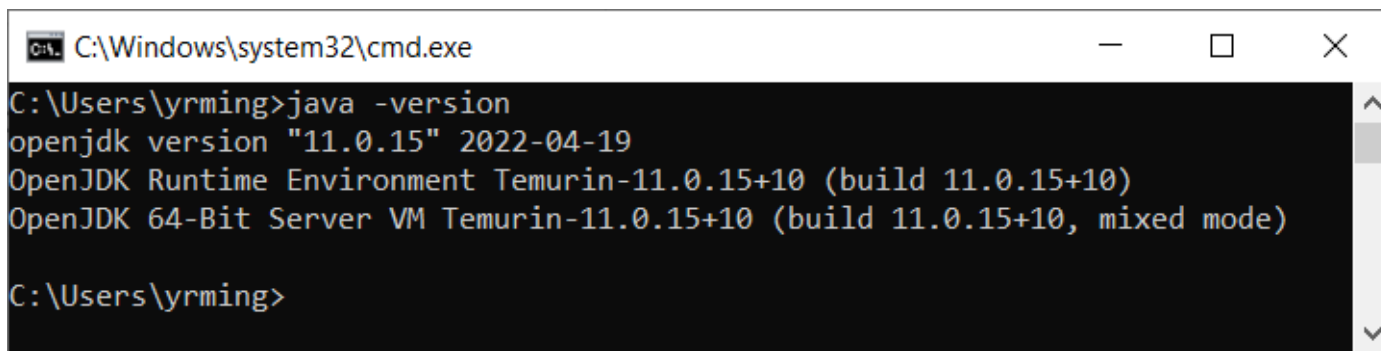
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- 当完成上述步骤后，可以打开一个命令行窗口，试验安装是否成功。如果有问题，可以检查上述两个环境变量在安装过程中有没有被正确地设置。
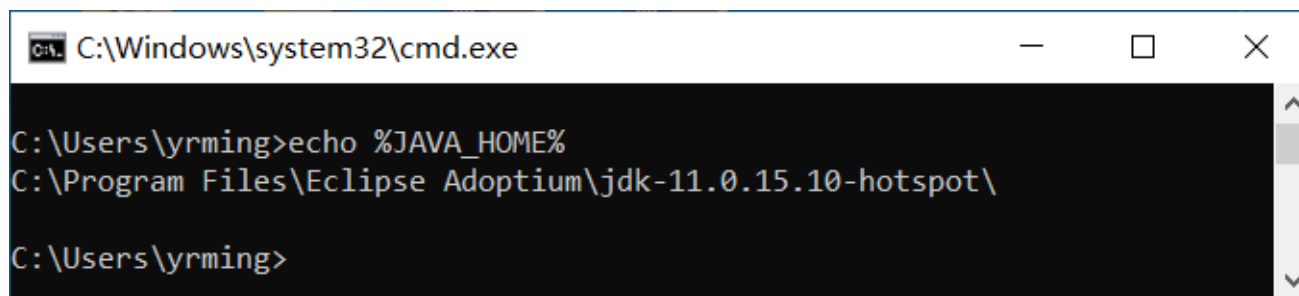
After completing the above steps, one can open a command-line window to test whether the installation was successful or not. If there is a problem, one can check whether the mentioned two environment variables are set correctly during the installation process.


```
C:\Windows\system32\cmd.exe                                    —    □    ×

C:\Users\yrming>java -version
openjdk version "11.0.15" 2022-04-19
OpenJDK Runtime Environment Temurin-11.0.15+10 (build 11.0.15+10)
OpenJDK 64-Bit Server VM Temurin-11.0.15+10 (build 11.0.15+10, mixed mode)

C:\Users\yrming>
```

```
C:\Windows\system32\cmd.exe                                    —    □    ×

C:\Users\yrming>echo %JAVA_HOME%
C:\Program Files\Eclipse Adoptium\jdk-11.0.15.10-hotspot\

C:\Users\yrming>
```

ThingsBoard安装
ThingsBoard Installation

- 由于实际业务中需要将一些物联网设备的信息和过程性数据进行永久化存储，因此需要相应永久化存储功能。ThingsBoard的存储功能由开源数据库PostgreSQL支持。

  The needs of the information about IoT devices and process data persistence during the business requires permanent storage to cater to it. The storage of ThingsBoard is supported by the open source database PostgreSQL.

- 首先安装由PostgreSQL提供的Java数据库连接（JDBC）驱动程序，可以通过访问以下网址进行下载安装：https://jdbc.postgresql.org/download.html。PostgreSQL提供的JDBC驱动有一个大的版本变动，在支持JDBC标准4.0特别是子版本4.2之后，版本更改为42.x.x命名方式。读者可以选择较新的版本进行下载，如42.2.24等。

  First install the Java database connectivity (JDBC) driver provided by PostgreSQL, which can be downloaded and installed by visiting: https://jdbc.postgresql.org/download.html. The JDBC driver provided by PostgreSQL has a major version name convention change. After implementation of JDBC standard 4.0, especially the subversion 4.2, the version is changed to the 42.x.x. Readers can choose a newer version to download, such as 42.2.24 and so on.

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- 下载之后，在安装的JDK目录下，建立目录jre\lib\ext\，即C:\Program Files\Eclipse Adoptium\jdk-11.0.15.10-hotspot\jre\lib\ext，将下载的Jar包，如postgresql-42.2.24.jar，移动到该目录下，如图所示：

After downloading, create a directory jre\lib\ext\ in the installed JDK directory, namely C:\Program Files\Eclipse Adoptium\jdk-11.0.15.10-hotspot\jre\lib\ext, and move the downloaded Jar package, such as postgresql-42.2 .24.jar, to this directory, as shown in the figure:

ThingsBoard安装
ThingsBoard Installation

▶ 从 PostgreSQL 网 站 下 载 较 新 的 数 据 库 管 理 程 序 ， 如 版 本 12.11 进 行 安 装 ：
https://www.enterprisedb.com/downloads/postgres-postgresql-downloads#windows。在 PostgreSQL
安装过程中间，系统会提示输入超级用户密码。用户根据自己情况选择一个合适的密码。因为
后续过程还会用到此密码，因此不要忘记。

Download a almost up-to-date database manager such as version 12.11 from the PostgreSQL website
to install: https://www.enterprisedb.com/downloads/postgres-postgresql-downloads#windows. During
the PostgreSQL installation process, you will be prompted for the superuser password. Users can
choose a suitable password according to their predercence. Do not forget this password as it will be
used in subsequent procedures.

▶ 下面来安装ThingsBoard服务，通过从Github网站上下载发布的压缩包，解压到特定的目录即可，
如 ： https://github.com/thingsboard/thingsboard/releases/download/v3.3.4.1/thingsboard-windows-
3.3.4.1.zip。假设用户解压后放置的目录为C:\Program Files (x86)\thingsboard。

Next, install the ThingsBoard service by downloading the released compressed package from the
Github website https://github.com/thingsboard/thingsboard/releases/download/v3.3.4.1/thingsboard -
windows-3.3.4.1.zip, and extracting it to a specific directory. Assume that the directory where the user
unzips is C:\Program Files (x86)\thingsboard.
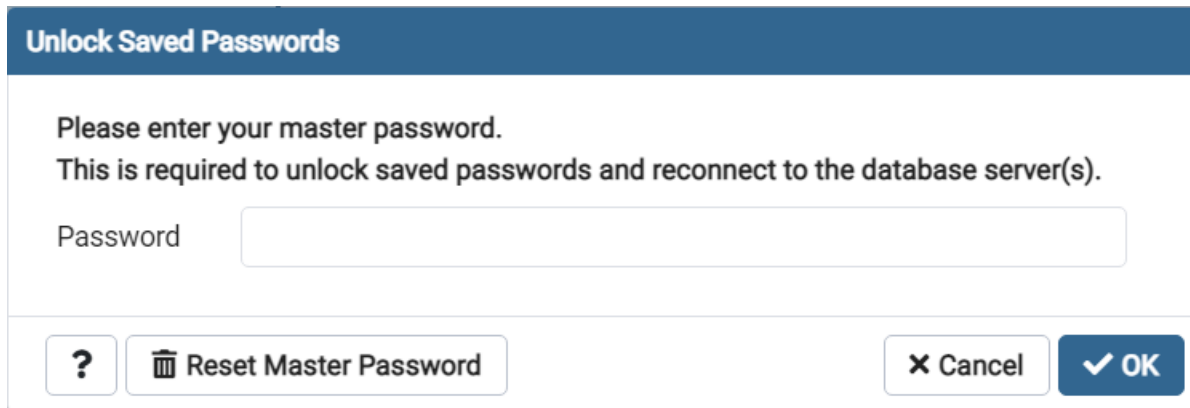
ThingsBoard安装
ThingsBoard Installation

- 注意，直接解压到C:\Program Files (x86)下面可能会因为用户权限问题不能成功，可以解压到下载目录，再移动到C:\Program Files (x86)目录下。

  Note that unzipping directly to C:\Program Files (x86) may fail due to user permission issues, you can extract it to the download directory, and then move it to the C:\Program Files (x86) directory.

- 下面，我们来配置数据库，首先通过开始菜单打开数据库管理器程序pgAdmin。注意首先会提示输入在安装过程中创建的密码：

  Next, let's configure the database, first open the database manager program pgAdmin through the start menu. Note that you will first be prompted for the password created during installation:

Unlock Saved Passwords

Please enter your master password.
This is required to unlock saved passwords and reconnect to the database server(s).

Password [   ]
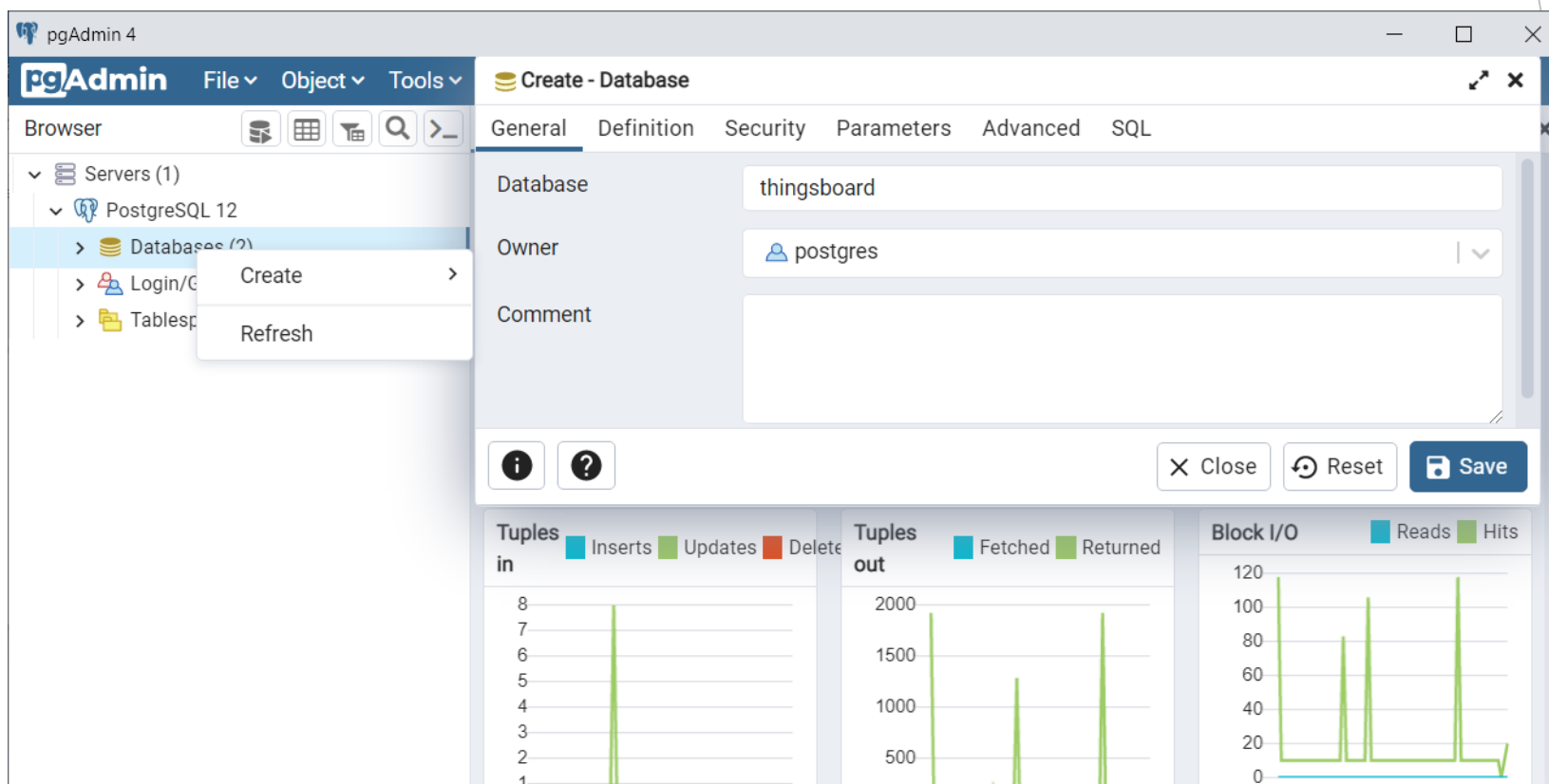
[?] [🗑 Reset Master Password]   [✕ Cancel] [✔ OK]

ThingsBoard安装
ThingsBoard Installation

▶ 在连接到数据库服务器之后，我们创建名称为"thingsboard"的数据库。

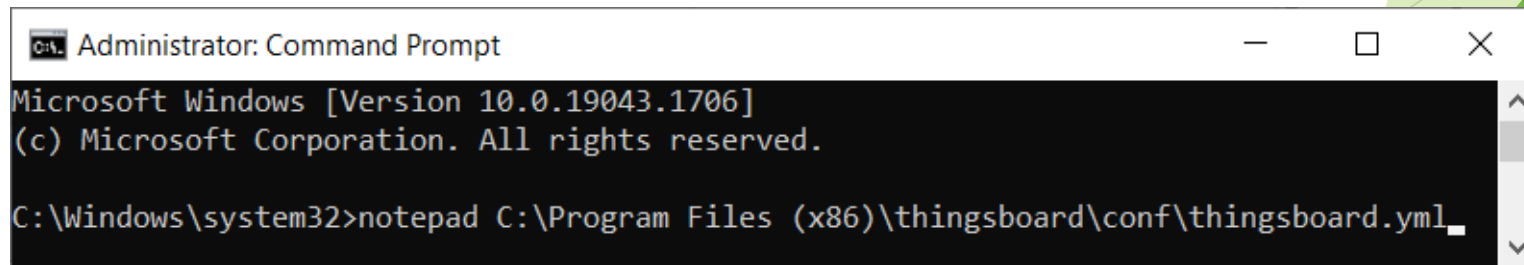After connecting to the database server, we create a database named "thingsboard".

ThingsBoard安装
ThingsBoard Installation

▶ 然后打开并编辑ThingsBoard的配置文件。注意，编辑该文件需要Windows管理员权限，可以在Windows左下角的搜索框里键入"cmd"，同时按下shift和ctrl键，再按Enter键以管理员身份打开，然后在命令行窗口里以如下方式如开：notepad C:\Program Files (x86)\thingsboard\conf\thingsboard.yml，如图所示。注意可以根据自己解压时的ThingsBoard的位置，实际调整配置文件的路径。

Then open and edit ThingsBoard's configuration file. Note that editing this file requires Windows administrator privileges. You can type "cmd" in the search box in the lower left corner of Windows Desktop, press the shift and ctrl keys at the same time, and then press Enter to open it as an administrator, and then in the command-line window enter the command as follows: notepad C:\Program Files (x86)\thingsboard\conf\thingsboard.yml, as indicated in Figure. Note that you can actually adjust the path of the configuration file according to the location of ThingsBoard when you decompress it.

```
Administrator: Command Prompt                    —    □    ×

Microsoft Windows [Version 10.0.19043.1706]
(c) Microsoft Corporation. All rights reserved.


C:\Windows\system32>notepad C:\Program Files (x86)\thingsboard\conf\thingsboard.yml_
```

ThingsBoard安装
ThingsBoard Installation

▶ 在打开的配置文件中，找到"#SQL DAO Configuration"语句块，将图中红框所示部分的用户信息替换为真实的信息，一般username就是图1.6创建数据库时的owner属性值，如postgres。

In the opened configuration file, find the "#SQL DAO Configuration" block, and replace the user information shown in the red box in the figure with real information. Generally, username is the value of the owner attribute when creating a database in Figure 1.6, such as postgres.

```
# SQL DAO Configuration
spring:
  data:
    jpa:
      repositories:
        enabled: "true"
  jpa:
    properties:
      javax.persistence.query.timeout: "${JAVAX_PERSISTENCE_QUERY_TIMEOUT:30000}"
    open-in-view: "false"
    hibernate:
      ddl-auto: "none"
    database-platform: "${SPRING_JPA_DATABASE_PLATFORM:org.hibernate.dialect.PostgreSQLDialect}"
  datasource:
    driverClassName: "${SPRING_DRIVER_CLASS_NAME:org.postgresql.Driver}"
    url: "${SPRING_DATASOURCE_URL:jdbc:postgresql://localhost:5432/thingsboard}"
    username: "${SPRING_DATASOURCE_USERNAME:         }"
    password: "${SPRING_DATASOURCE_PASSWORD:    }"
    hikari:
      maximumPoolSize: "${SPRING_DATASOURCE_MAXIMUM_POOL_SIZE:16}"
```

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▶ 虽然PostgreSQL的单张表的大小可以支持到32TB，但大表对数据库性能有明显的影响，因此可能根据时间段，对大表进行合理的拆分。如果想控制时间粒度，则可以定位如下图中所示的参数ts_key_value_partitioning，设置一个合理的值。如果部署在实验室环境，每天都有不同的班进行上课，可以设置为DAYS。

Although the size of a single table of PostgreSQL can be up to 32TB, however, large tables have a significant impact on database performance, so it is reasonable to split large tables according to time periods. To refine the time granularity, you can locate the parameter ts_key_value_partitioning shown in the following figure and set a reasonable value. If deployed in a laboratory environment, there are different classes participate every day, then it can be set to DAYS.

```
postgres:
  # Specify partitioning size for timestamp key-value storage. Example: DAYS, MONTHS, YEARS, INDEFINITE.
  ts_key_value_partitioning: "${SQL_POSTGRES_TS_KV_PARTITIONING:MONTHS}"
```

ThingsBoard安装
ThingsBoard Installation

▶ ThingsBoard使用多种消息系统/代理来缓存和协同 ThingsBoard 服务之间的消息和通信，其默认实现是基于内存模式，应用的比较多的是基于Kaffa开源流计算平台，也有基于流行的消息队列如RabbitMQ，另外还可以基于商业系统，如AWS SQS，Google Pub/Sub等等。 如何选择合适的队列实现可能取决于需求。在实验室环境，基于默认的内存方式实现就可以。我们先以基于内存方式实现讲解，这意味着不需要额外的操作。

ThingsBoard uses a variety of messaging systems/brokers to cache and coordinate messages and communications between ThingsBoard services. The default implementation is based on memory. Most of the applications are based on the Kaffa open source stream computing platform, and some are based on popular message queues such as RabbitMQ, and can also be based on commercial systems such as AWS SQS, Google Pub/Sub, etc. How to choose an appropriate queue implementation may depend on requirements. In the laboratory environment, the implementation based on the default memory mechanism is sufficient. Let's first explain the process based on memory, which indicates no further configuration is needed.

ThingsBoard安装
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- ThingsBoard使用多种消息系统/代理来缓存和协同 ThingsBoard 服务之间的消息和通信，其默认实现是基于内存模式，应用的比较多的是基于Kaffa开源流计算平台，也有基于流行的消息队列如RabbitMQ，另外还可以基于商业系统，如AWS SQS，Google Pub/Sub等等。 如何选择合适的队列实现可能取决于需求。在实验室环境，基于默认的内存方式实现就可以。我们先以基于内存方式实现讲解，这意味着不需要额外的操作。

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ThingsBoard安装
ThingsBoard Installation

- ThingsBoard基于Java的Spring框架实现，一般经验是，Java虚拟机的性能与内存具有较密切的关联，特别是Java语言的自动垃圾回收机制，变量的销毁与资源的释放可能会有延迟。如果能够在虚拟机启动时提供较多的物理内存，虚拟机会有更高的性能表现。但如果部署的机器本身内存较小，则需要限制虚拟机对内存的使用，以免对系统的整体性能造成影响。可通过ThingsBoard配置文件中的如下参数限制对内存的使用。读者可以自行将其调整为合适的值后，进行保存。

ThingsBoard is implemented based on Java's Spring framework. The general experience is that the performance of the Java virtual machine is closely related to memory, especially the automatic garbage collection mechanism of the Java language. There may be a delay in the destruction of variables and the release of resources. The virtual machine can have higher performance if more physical memory is provided when the virtual machine starts. However, if the machine itself has a small memory, it is necessary to limit the memory usage of the virtual machine so as not to affect the overall performance of the system. The memory usage can be limited by the following parameters in the ThingsBoard configuration file. Readers can adjust them to an appropriate values then save.

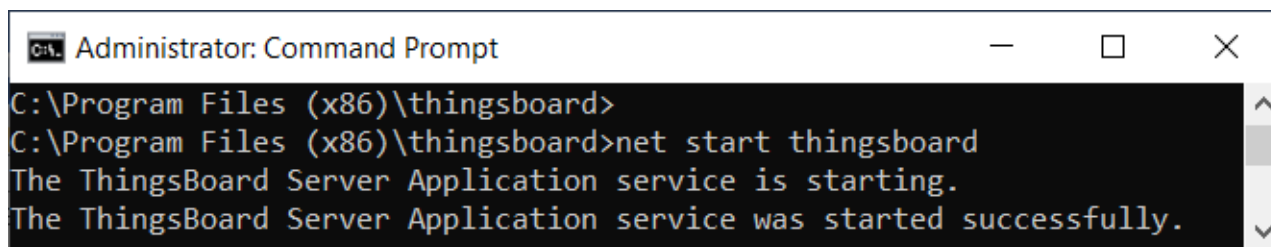<startargument>-Xms512m</startargument>

<startargument>-Xmx1024m</startargument>

ThingsBoard安装
ThingsBoard Installation

▶ 在上述步骤全部准备好之后，便可以安装ThingsBoard服务，以便其以无人值守的方式运行。具体地，以管理员身份打开命令行，切换到ThingsBoard的安装目录，即C:\Program Files (x86)\thingsboard>，然后执行脚本install.bat进行安装。也可在安装的同时，加载demo数据以便观察，此时运行install.bat --loadDemo即可。在完全安装好之后，可以通过net start thingsboard命令将thingsboard作为服务启动起来。

Once the above steps are all in place, the ThingsBoard service can be installed so that it runs in an unattended way. Specifically, open the command line as an administrator, switch to the installation directory of ThingsBoard, that is, C:\Program Files (x86)\thingsboard>, and then execute the script install.bat to install. You can also load the demo data for observation with installation. At this time, you can run install.bat --loadDemo. Once fully installed, thingsboard can be started as a service with the command net start thingsboard.

```
Administrator: Command Prompt                    —    □    ×

C:\Program Files (x86)\thingsboard>
C:\Program Files (x86)\thingsboard>net start thingsboard
The ThingsBoard Server Application service is starting.
The ThingsBoard Server Application service was started successfully.
```

ThingsBoard安裝
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ThingsBoard安装
ThingsBoard Installation

▶ 至此用户可以通过浏览器，通过如下网址：http://localhost:8080/，访问Web UI，如图所示。当我们在安装ThingsBoard时指定loadDemo选项时，会默认建立如下用户账户信息：

- 系统管理员：sysadmin@thingsboard.org / sysadmin

- 租户管理员：tenant@thingsboard.org / 租户

- 客户用户：customer@thingsboard.org / customer

我们可以用上面用户信息登录，且用户信息可以在用户画像（Profile）界面进行修改。

▶ Now the user can access the Web UI through the browser through the following URL: http://localhost:8080/, as shown in the figure. When we specify the loadDemo option when installing ThingsBoard, the following user account information will be created by default:

- System Administrator: sysadmin@thingsboard.org / sysadmin

- Tenant Administrator: tenant@thingsboard.org / tenant

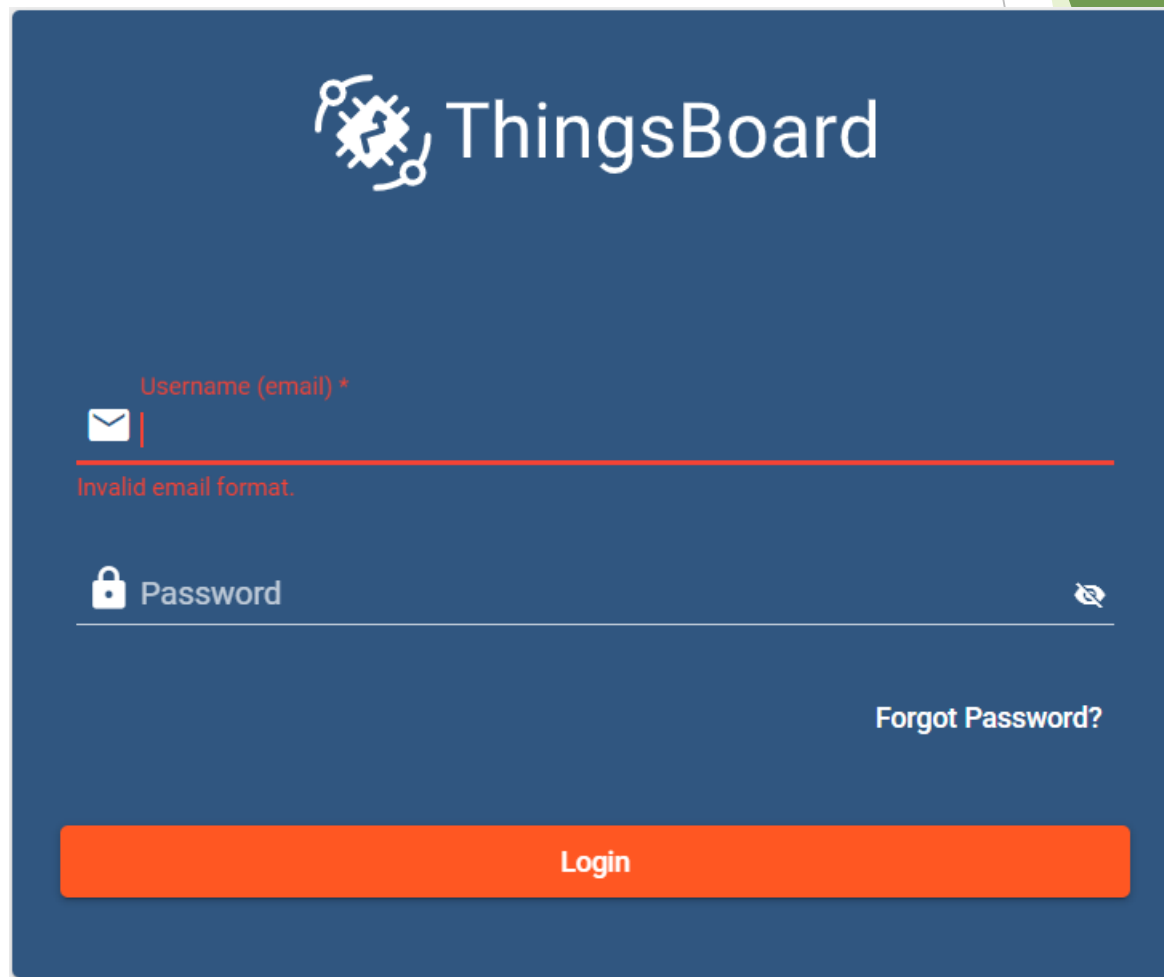- Customer User: customer@thingsboard.org / customer

We can log in with the above user information, and the user information can be modified in the user profile (Profile) interface.

ThingsBoard安装
ThingsBoard Installation

- ThingsBoard 的 日 志 信 息 记 录 在 C:\Program Files (x86)\thingsboard\logs 目 录 下，名 称 为 thingsboard.log 。 当 ThingsBoard工作有问题时，可以 通过查看日志文件来解决问题。

The log information of ThingsBoard is recorded in the C:\Program Files (x86)\thingsboard\logs directory with the name thingsboard.log. When there is a problem with ThingsBoard working, the problem can be solved by check the log file.

ThingsBoard相关概念
ThingsBoard Terminology

▶ 在使用ThingsBoard之前，我们来先熟悉一下ThingsBoard中的相关概念。ThingsBoard提供了用户界面和REST API来配置和管理IoT应用程序中的多个实体类型及其关系，支持的实体包括：

Before using ThingsBoard, let's get ourselves be familiar the terminologies of ThingsBoard. ThingsBoard provides the user interface and REST APIs to provision and manage multiple entity types and their relations in your IoT application. Supported entities are:

▶ 租户—可以将租户视为一个单独的商业实体：它是拥有或运用设备和资产的个人或组织；租户实体可能有多个租户管理员用户和数百万的客户、设备和资产；

Tenants - you can treat the tenant as a separate business-entity: it's an individual or an organization who owns or produce devices and assets; Tenant may have multiple tenant administrator users and millions of customers, devices and assets;

ThingsBoard相关概念
ThingsBoard Terminology

- 客户—客户也是一个独立的商业实体：购买或使用租户设备和/或资产的个人或组织； 客户可能有多个用户和数百万的设备和/或资产；

  Customers - the customer is also a separate business-entity: individual or organization who purchase or uses tenant devices and/or assets; Customer may have multiple users and millions of devices and/or assets;

- 用户—用户是能够浏览仪表板和管理实体；

  Users - users are able to browse dashboards and manage entities;

- 设备—可以产生遥测数据和处理 RPC 命令的基本物联网实体。 例如，传感器、执行器、开关；

  Devices - basic IoT entities that may produce telemetry data and handle RPC commands. For example, sensors, actuators, switches;

- 资产—可能与其他设备和资产相关的抽象物联网实体。例如工厂、场地、车辆；

  Assets - abstract IoT entities that may be related to other devices and assets. For example factory, field, vehicle;

ThingsBoard相关概念
ThingsBoard Terminology

- 实体视图—如果您只想与客户共享部分设备或资产数据，则很有用；

  Entity Views - useful if you like to share only part of device or asset data to the customers;

- 警报—识别您的资产、设备或其他实体问题的事件；

  Alarms - events that identify issues with your assets, devices, or other entities;

- 仪表板—物联网数据的可视化以及通过用户界面控制特定设备的能力；

  Assets - abstract IoT entities that may be related to other devices and assets. For example factory, field, vehicle;

- 规则节点—传入消息、实体生命周期事件等的处理单元；

  Rule Node - processing units for incoming messages, entity lifecycle events, etc;

- 规则链—定义规则引擎中的处理流程。可能包含许多规则节点和到其他规则链的链接；

  Rule Chain - defines the flow of the processing in the Rule Engine. May contain many rule nodes and links to other rule chains;

ThingsBoard相关概念
ThingsBoard Terminology

- 每个实体支持：

  - 属性—与实体关联的静态和半静态键值对，例如序列号、型号、固件版本；

  - 时间序列数据—可用于存储、查询和可视化的时间序列数据点，例如温度、湿度、电池电量；

  - 关系—与其他实体的定向连接，例如包含、管理、拥有、生产。

- Each entity supports:

  - Attributes - static and semi-static key-value pairs associated with entities. For example serial number, model, firmware version;

  - Time-series data - time-series data points available for storage, querying and visualization. For example temperature, humidity, battery level;

  - Relations - directed connections to other entities. For example contains, manages, owns, produces.

ThingsBoard相关概念
ThingsBoard Terminology

▶ 一些实体支持配置文件（或画像）：

  ▶ 租户配置文件—包含多个租户的通用设置：实体、API 和速率限制等。每个租户在单个时间点都有一个也是唯一的配置文件。

  ▶ 设备配置文件—包含多个设备的通用设置：处理和传输配置等。每个设备在单个时间点都有一个也是唯一的配置文件。。

▶ Some entities support profiles:

  ▶ Tenant Profiles - contains common settings for multiple tenants: entity, API and rate limits, etc. Each Tenant has the one and only profile at a single point in time.

  ▶ Device Profiles - contains common settings for multiple devices: processing and transport configuration, etc. Each Device has the one and only profile at a single point in time.