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A night-time aerial view of a city skyline with numerous skyscrapers. Overlaid on the image is a network diagram consisting of white nodes connected by thin white lines. Several of these nodes are accompanied by blue Wi-Fi signal icons, representing IoT connectivity across the urban environment.

# STM32U5 Azure IoT Hands-on

Alnur ELBERIER

October 2022

# Agenda

1 Download Material

2 Check Requirements

3 Hardware

4 Security

5 X-Cube-Azure Walkthrough

6 Board Distribution

7 Hands-On

8 Option Byte Reset

# Download Material

# Workshop Material

Please choose one of download options below

## Option 1: Zip Download Link

- <https://tinyurl.com/st-iot>

## Option 2: Clone GitHub Repo

- `git clone https://github.com/AlnurElberier/ST\_Azure\_Workshop\_2022.git`

# Check Requirements

# Workshop Requirements

- Windows
- Python3
  - Pyserial
- Azure CLI
- STM32CubeProgrammer
- Git Hub
- X-CUBE-AZURE

# Pre-Requisite Check Script

- Navigate to the ST\_Azure\_Workshop folder you just downloaded
- Double click the AzCheckPrereq.bat script

Name	Date modified	Type	Size
AzCheckPrereq.bat	9/15/2022 12:58 PM	Windows Batch File	2 KB
IoT_Central_Workshop.pdf	9/15/2022 12:58 PM	Microsoft Edge P...	5,808 KB
STM32U5 Azure IoT Hands-on_9_15_22.pdf	9/15/2022 12:58 PM	Microsoft Edge P...	1,144 KB

```
C:\WINDOWS\system32\cmd.exe
STM32CubeProgrammer Successfully Installed
Python 3.10.7
Python Successfully Installed
Requirement already satisfied: pyserial in c:\users\alnur elberier\scoop\persist\python\lib\site-packages (3.5)
azure-cli 2.34.1 *
core 2.34.1 *
telemetry 1.0.6 *
Extensions:
account 0.2.3
azure-iot 0.17.1
Dependencies:
msal 1.16.0
azure-mgmt-resource 20.0.0
Python location 'C:\Program Files (x86)\Microsoft SDKs\Azure\CLI2\python.exe'
Extensions directory 'C:\Users\alnur elberier\.azure\cliextensions'
Python (Windows) 3.8.9 (tags/v3.8.9:a743f81, Apr 6 2021, 13:22:56) [MSC v.1928 32 bit (Intel)]
Legal docs and information: aka.ms/AzureCliLegal
AZ CLI Successfully Installed
```

# Hardware



# STM32U5 Microcontrollers

The new reference for secure and smart IoT applications



## Higher Security

Certified PSA L3 and SESIP L3

## Lower Power

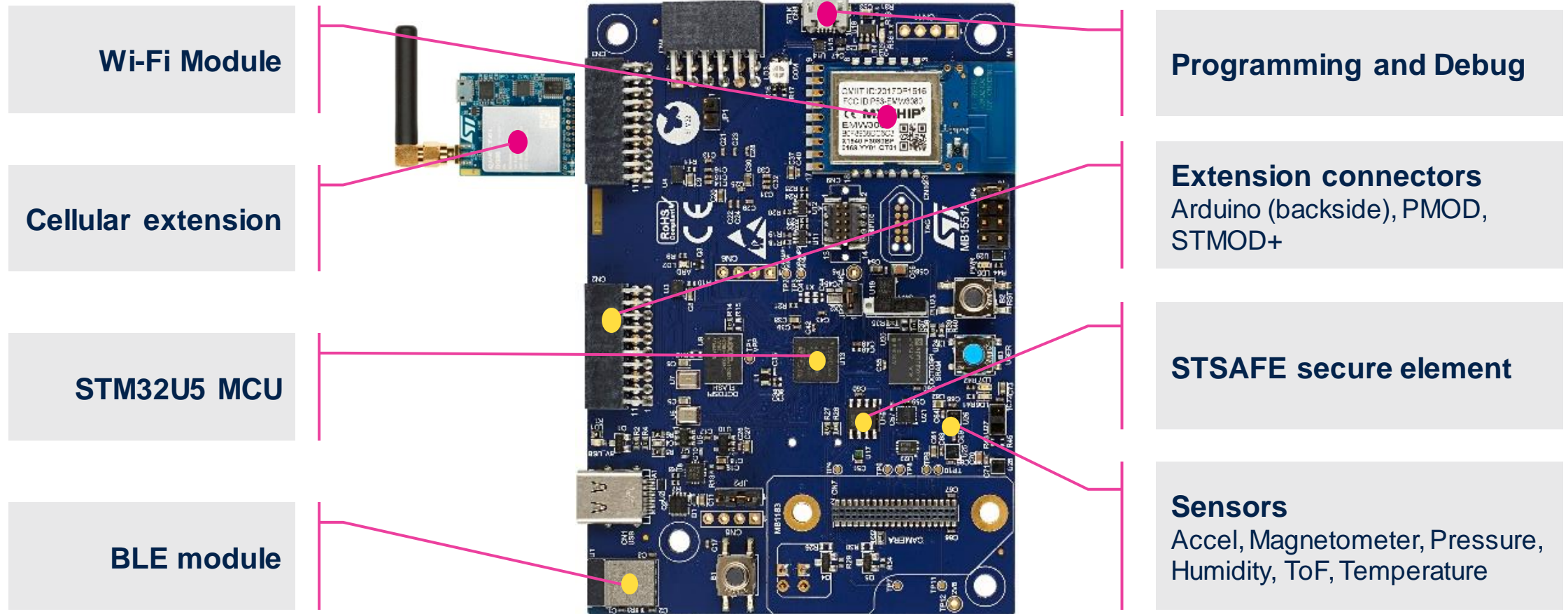
58 ULPMark-CM

## Richer applications

Cortex-M33 @160MHz, extended features set

# STM32U5 IoT Kit

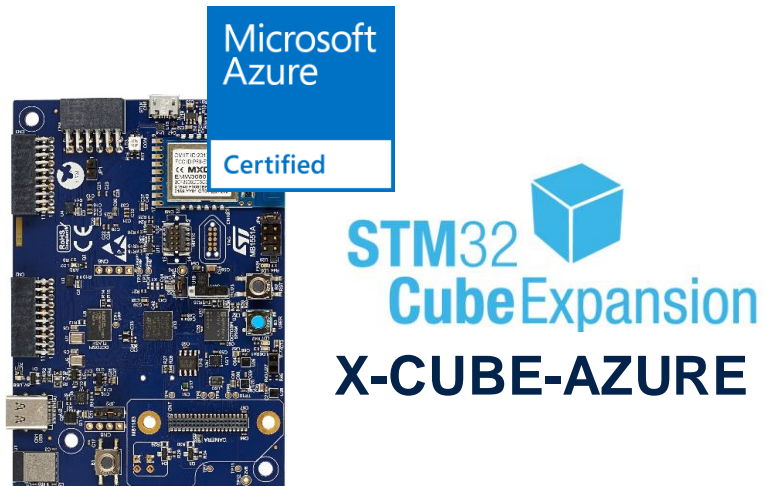
Your reference board for IoT Proof-of-Concept



B-U585H-IOT02A

# Azure IoT on STM32U5

**X-CUBE-AZURE reference integration simplifying your development**



**Certified for Microsoft Azure plug and play**

**Leveraging ARM Trusted Firmware-M (TF-M)**

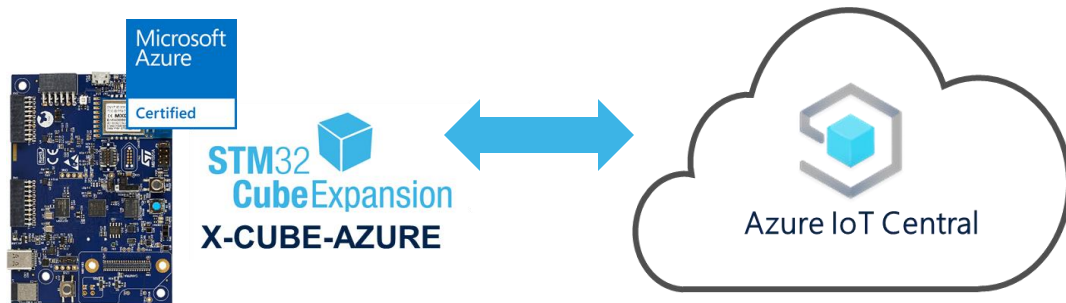
**Based on AzureRTOS middleware**

**Supporting WIFI and Cellular (Cat M1)**

**using STSAFE for simpler provisioning and even higher security**

# Azure IoT on STM32U5

## Reference implementation supporting Azure IoT and app Services



### Azure IoT Central

Data visualization and analysis, device management and

### Azure IoT Hub

device provisioning services

### IoT plug and Play

### Device update for IoT Hub (public preview)

### Microsoft Defender for IoT

# Azure IoT Central Quick Connect

## Abstracts Firmware customization and registration process

- Allows Cloud IoT/Data architects to focus on developing power of the Cloud IoT platform proof of concepts.
- Connect to Microsoft Azure IoT Central and perform telemetry in minutes
- Solution Components:
  - *B-U585I-IOT02A Discovery Kit*
  - *Reference Binary*
  - *Quick connect scripts*
  - *Cloud visualization*

# Security



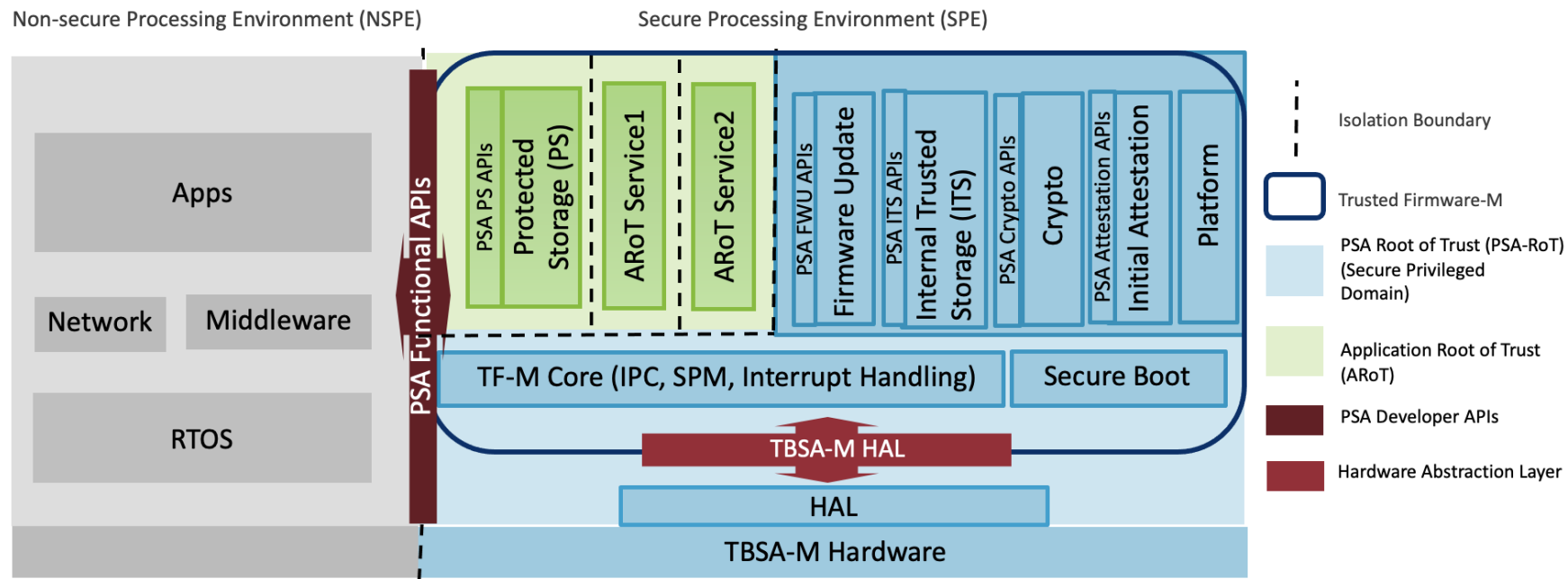
## Azure RTOS + ST U5 Security Overview

Using ST's Secure, Ultra Low Power, Sensor to Cloud Reference Hardware



# Trusted Firmware-M (TF-M)

- Trusted Firmware for Cortex M (TF-M) implements the Secure Processing Environment (SPE) for Armv8-M, Armv8.1-M
- **Trusted Firmware-M consists of:**
  - Secure Boot , Control the isolation, communication and execution within SPE and with NSPE
  - Crypto, Internal Trusted Storage (ITS), Protected Storage (PS) and Attestation secure services





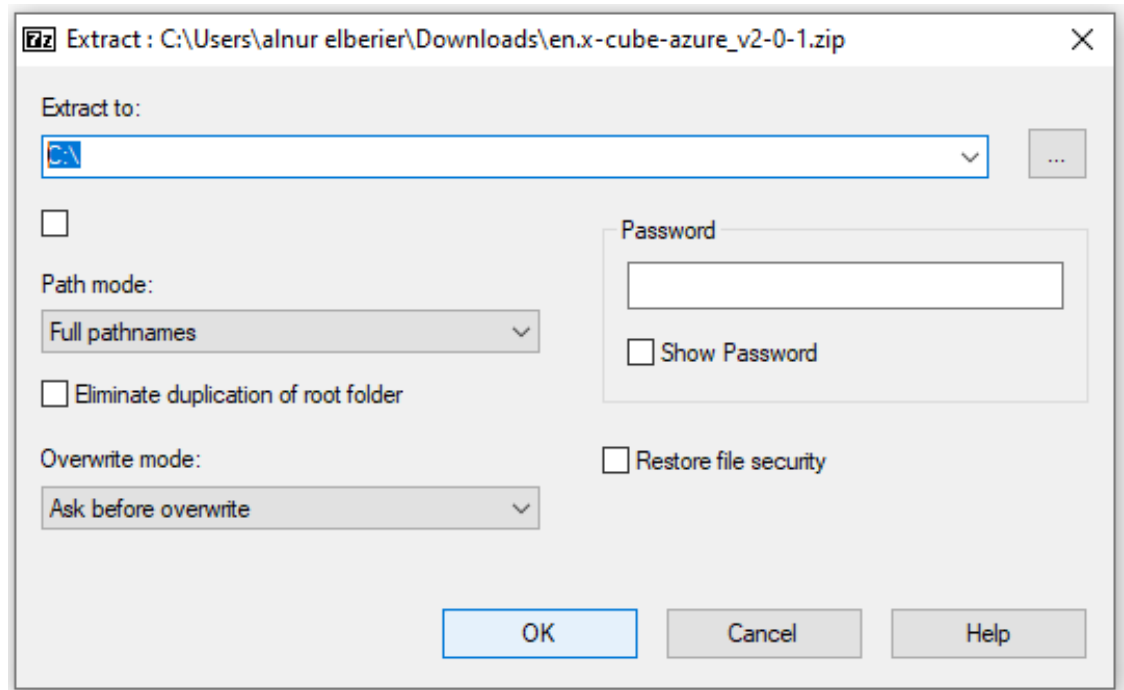
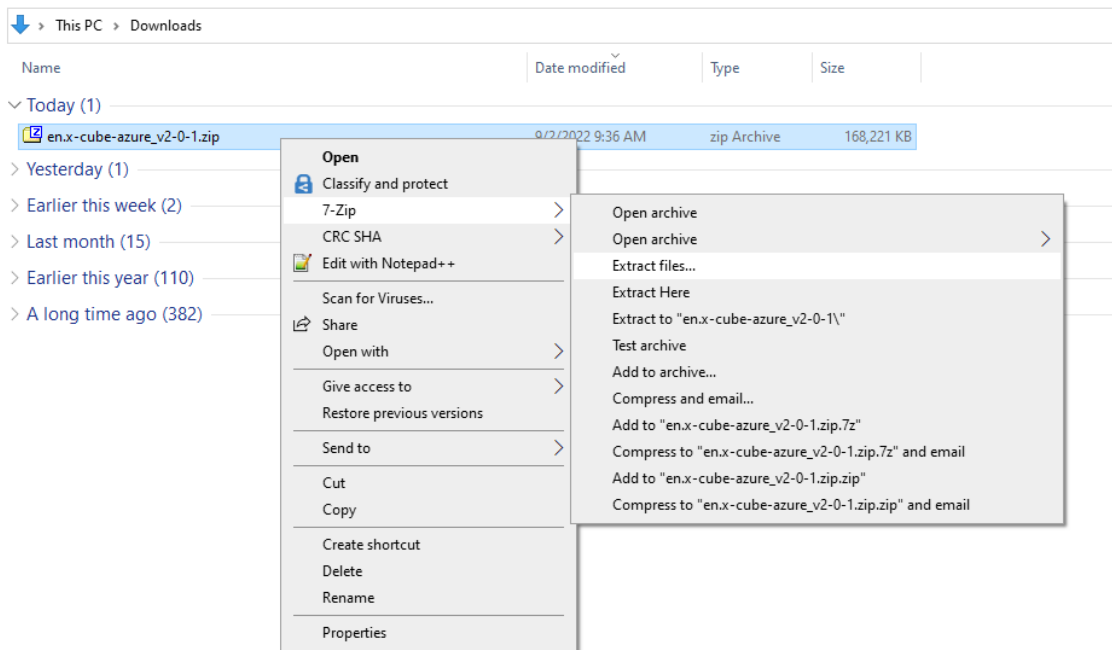
# Directory Walk-Through X-CUBE-AZURE

- Download the X-CUBE-AZURE Software package and become familiar with the directory structure
- Download Link:
  - [www.st.com/en/embedded-software/x-cube-azure](http://www.st.com/en/embedded-software/x-cube-azure)



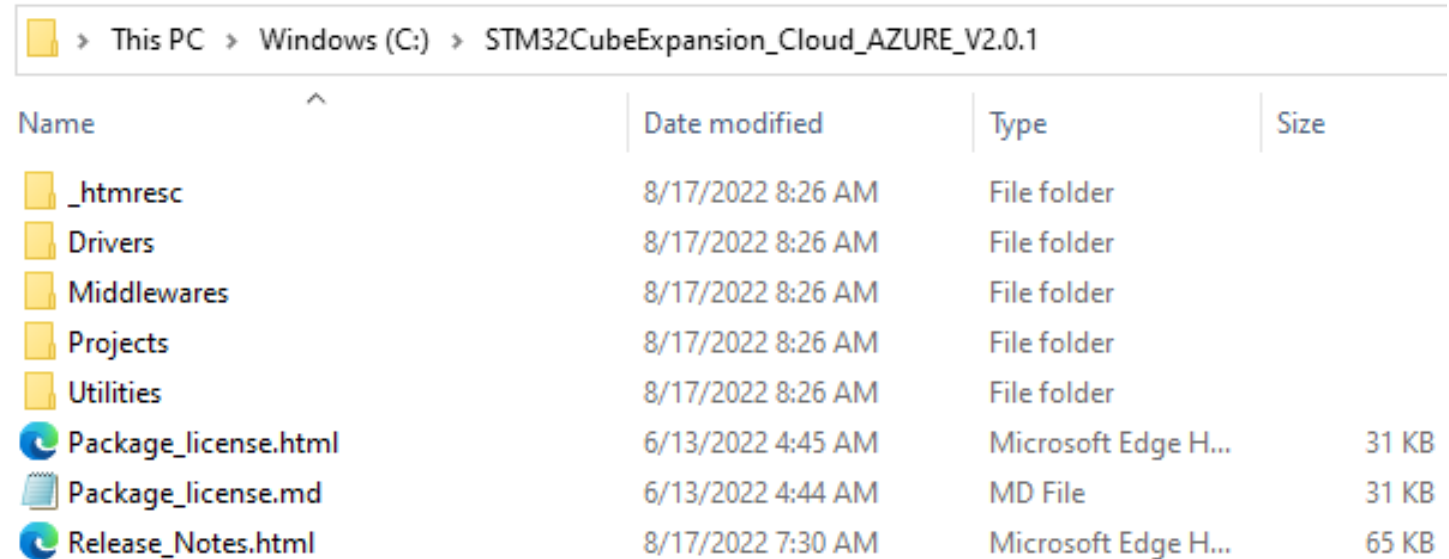
# Extracting X-CUBE-AZURE to C Drive

- Navigate to download directory
- Select the **en.x-cube-azure\_v2-0-1.zip** file you just downloaded
- Extract the file to your **C drive**



# X-CUBE-AZURE Root Directory

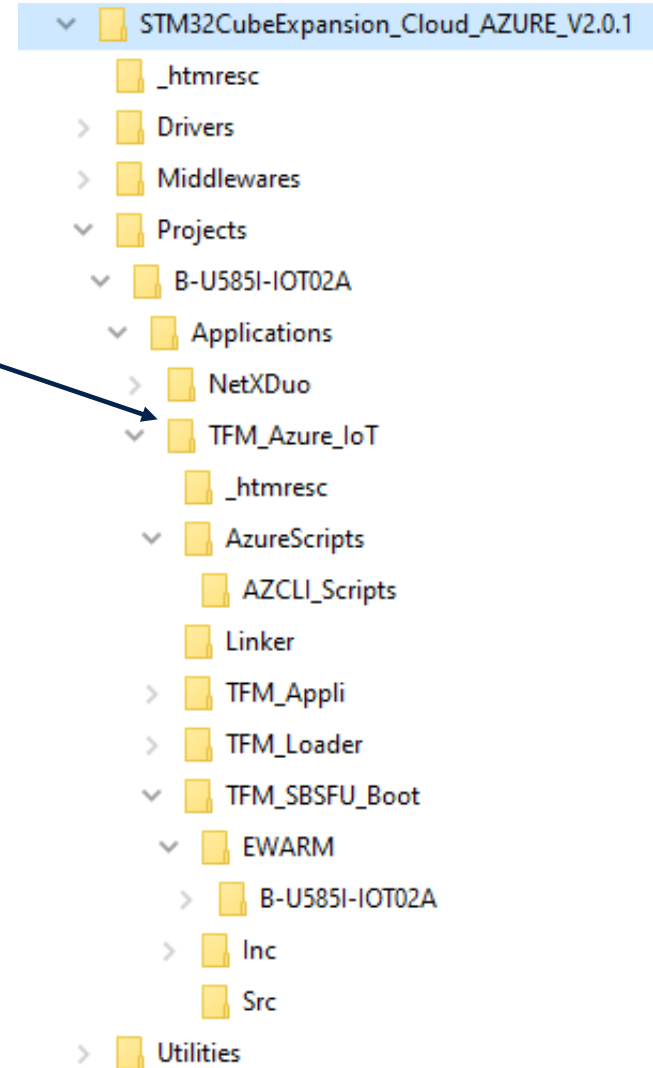
- Drivers
  - BSP, CMSIS, and HAL Drivers
- Middlewares
  - Both ST and Third-Party Middleware
- Projects
  - Sample Projects and applications
- Utilities
  - Additional software and patches



Name	Date modified	Type	Size
_htmresc	8/17/2022 8:26 AM	File folder	
Drivers	8/17/2022 8:26 AM	File folder	
Middlewares	8/17/2022 8:26 AM	File folder	
Projects	8/17/2022 8:26 AM	File folder	
Utilities	8/17/2022 8:26 AM	File folder	
Package_license.html	6/13/2022 4:45 AM	Microsoft Edge H...	31 KB
Package_license.md	6/13/2022 4:44 AM	MD File	31 KB
Release_Notes.html	8/17/2022 7:30 AM	Microsoft Edge H...	65 KB

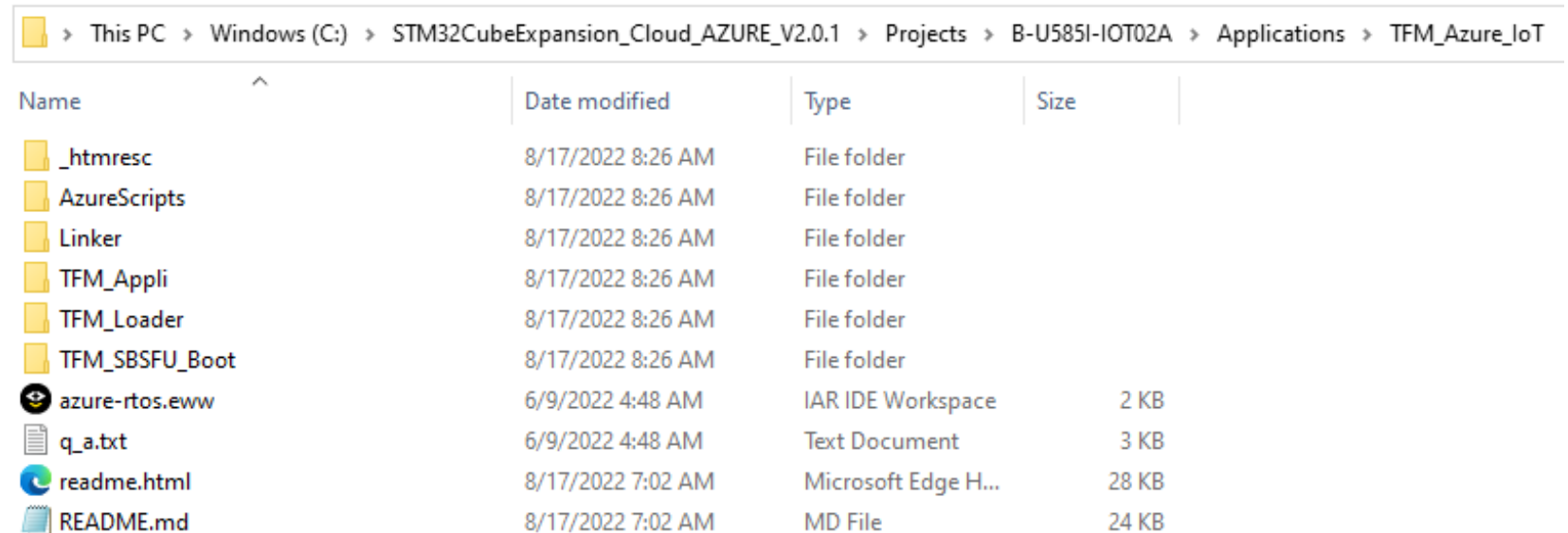
# X-CUBE-AZURE Directory Structure

- Project directory containing application code and documentation



# X-CUBE-AZURE TFM\_Azure\_IoT

- Azure Scripts
  - Supporting software
- Linker
- TFM\_Appli
  - Main application
- TFM\_Loader
- TFM\_SBSFU\_Boot
  - Boot firmware and scripts
- azure-rtos.eww
  - EWARm project shortcut

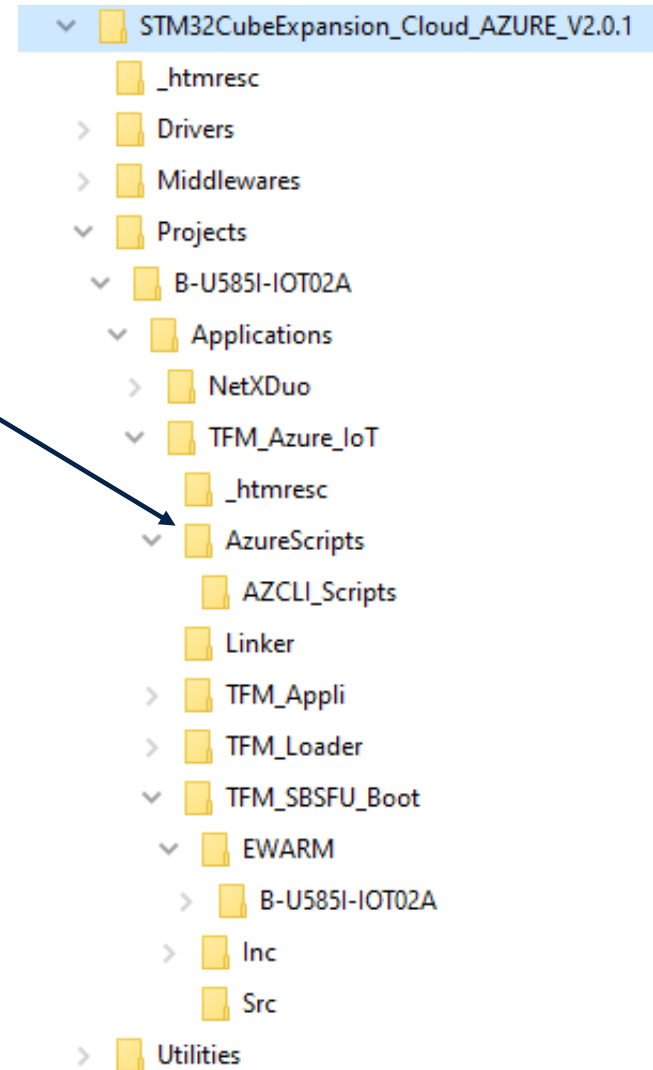


Name	Date modified	Type	Size
_htmresc	8/17/2022 8:26 AM	File folder	
AzureScripts	8/17/2022 8:26 AM	File folder	
Linker	8/17/2022 8:26 AM	File folder	
TFM_Appli	8/17/2022 8:26 AM	File folder	
TFM_Loader	8/17/2022 8:26 AM	File folder	
TFM_SBSFU_Boot	8/17/2022 8:26 AM	File folder	
azure-rtos.eww	6/9/2022 4:48 AM	IAR IDE Workspace	2 KB
q_a.txt	6/9/2022 4:48 AM	Text Document	3 KB
readme.html	8/17/2022 7:02 AM	Microsoft Edge H...	28 KB
README.md	8/17/2022 7:02 AM	MD File	24 KB



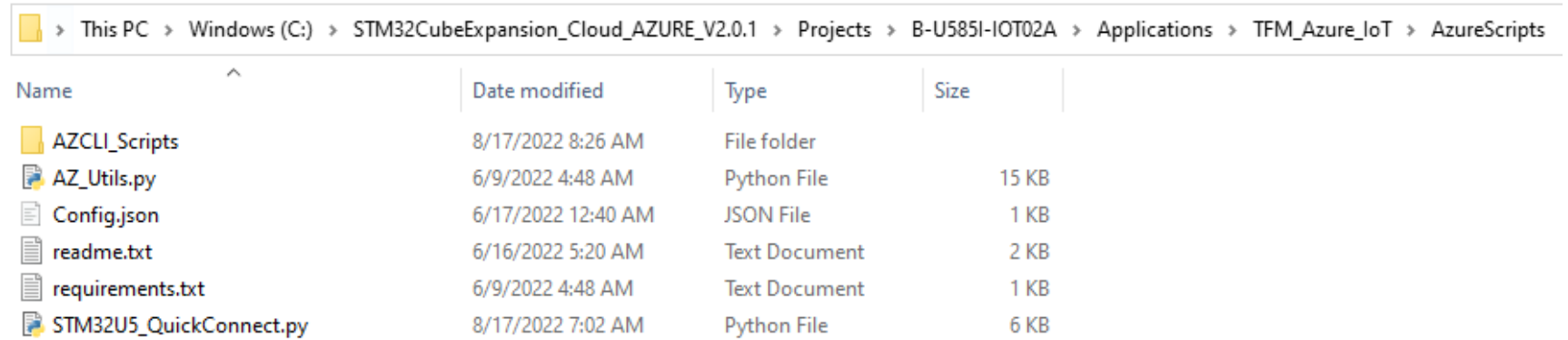
# X-CUBE-AZURE Directory Structure

- Script directory that contains all the files pertaining to this hands-on



# X-CUBE-AZURE TFM\_Azure\_IoT\AzureScripts\

- **Config.json**
  - Configuration file for Quick Connect Script
- **Requirements.txt**
  - Python library requirements
- **STM32U5\_QuickConnect.py**
  - Quick connect script for connecting B-U585I-IOT02A to Azure IoT Central

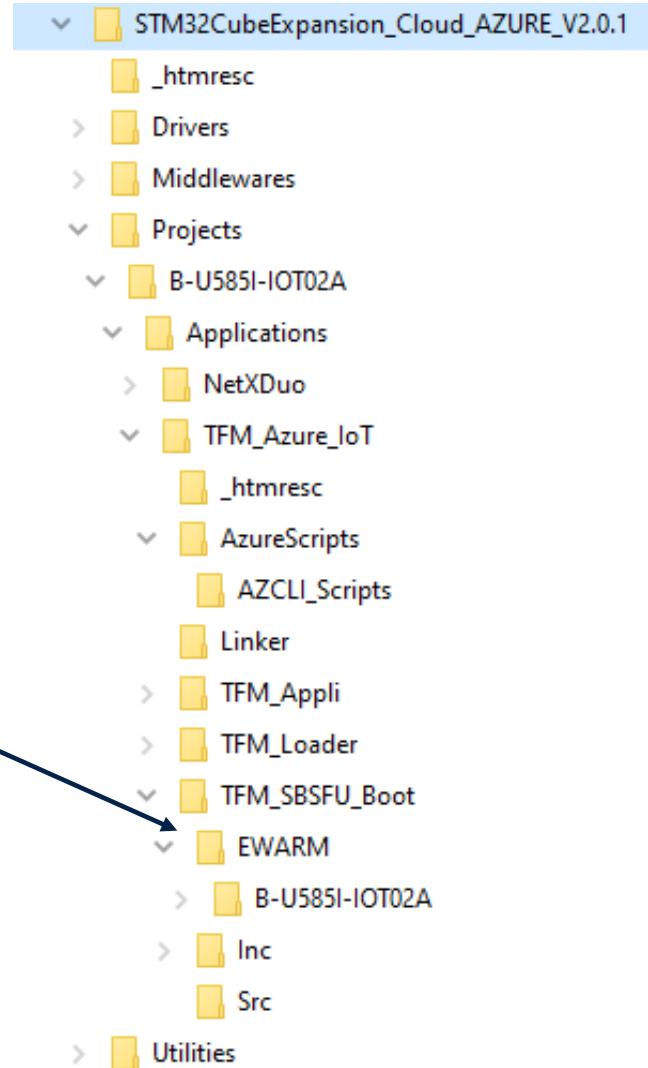


Name	Date modified	Type	Size
AZCLI_Scripts	8/17/2022 8:26 AM	File folder	
AZ_Utils.py	6/9/2022 4:48 AM	Python File	15 KB
Config.json	6/17/2022 12:40 AM	JSON File	1 KB
readme.txt	6/16/2022 5:20 AM	Text Document	2 KB
requirements.txt	6/9/2022 4:48 AM	Text Document	1 KB
STM32U5_QuickConnect.py	8/17/2022 7:02 AM	Python File	6 KB



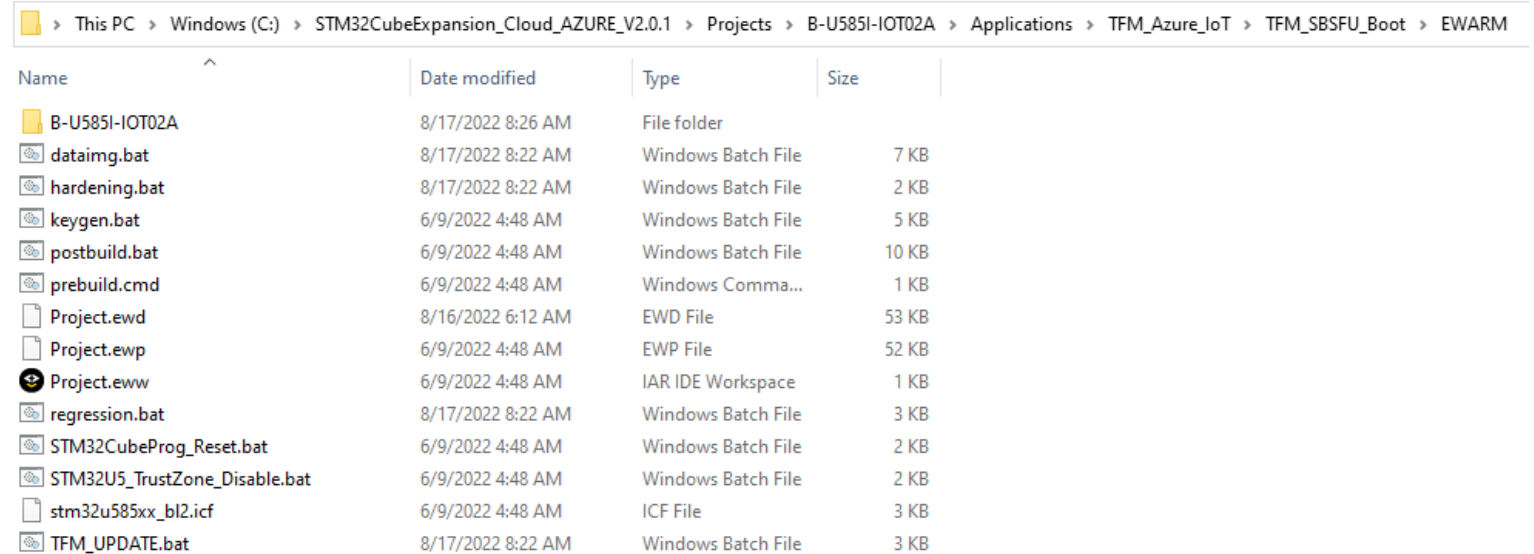
# X-CUBE-AZURE Directory Structure

- Utility script directory used to set option bytes and flash firmware



# X-CUBE-AZURE TFM\_Azure\_IoT\TFM\_SBSFU\_Boot\EWARM

- regression.bat
  - Script to set option bytes on board
- TFM\_UPDATE.bat
  - Flashing Script
- STM32CubeProg\_Reset.bat
  - Script to reset board
- STM32U5\_TrustZone\_Disable.bat
  - Script to disable TZ option byte



Name	Date modified	Type	Size
B-U585I-IOT02A	8/17/2022 8:26 AM	File folder	
dataimg.bat	8/17/2022 8:22 AM	Windows Batch File	7 KB
hardening.bat	8/17/2022 8:22 AM	Windows Batch File	2 KB
keygen.bat	6/9/2022 4:48 AM	Windows Batch File	5 KB
postbuild.bat	6/9/2022 4:48 AM	Windows Batch File	10 KB
prebuild.cmd	6/9/2022 4:48 AM	Windows Comma...	1 KB
Project.ewd	8/16/2022 6:12 AM	EWD File	53 KB
Project.ewp	6/9/2022 4:48 AM	EWP File	52 KB
Project.eww	6/9/2022 4:48 AM	IAR IDE Workspace	1 KB
regression.bat	8/17/2022 8:22 AM	Windows Batch File	3 KB
STM32CubeProg_Reset.bat	6/9/2022 4:48 AM	Windows Batch File	2 KB
STM32U5_TrustZone_Disable.bat	6/9/2022 4:48 AM	Windows Batch File	2 KB
stm32u585xx_bl2.icf	6/9/2022 4:48 AM	ICF File	3 KB
TFM_UPDATE.bat	8/17/2022 8:22 AM	Windows Batch File	3 KB

# Board Distribution

# Boards distribution

- Believe it or not, even at ST we have hard time to get boards. Unfortunately, we need to collect the board at the end of the workshop to use them in the next one.
- We'll disinfect the boards at the end of the workshop and before re-distribution.
- A voucher will be handed out at the end of hands-on



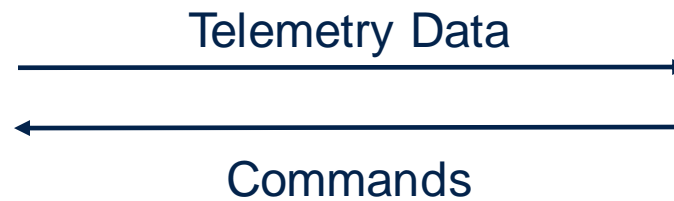
# Hands-On: Quick Connect

# Goal

- Create an [Azure IoT Central application](#) and connect the [B-U585I-IOT02A - Discovery kit for IoT node](#) for bi-directional communication



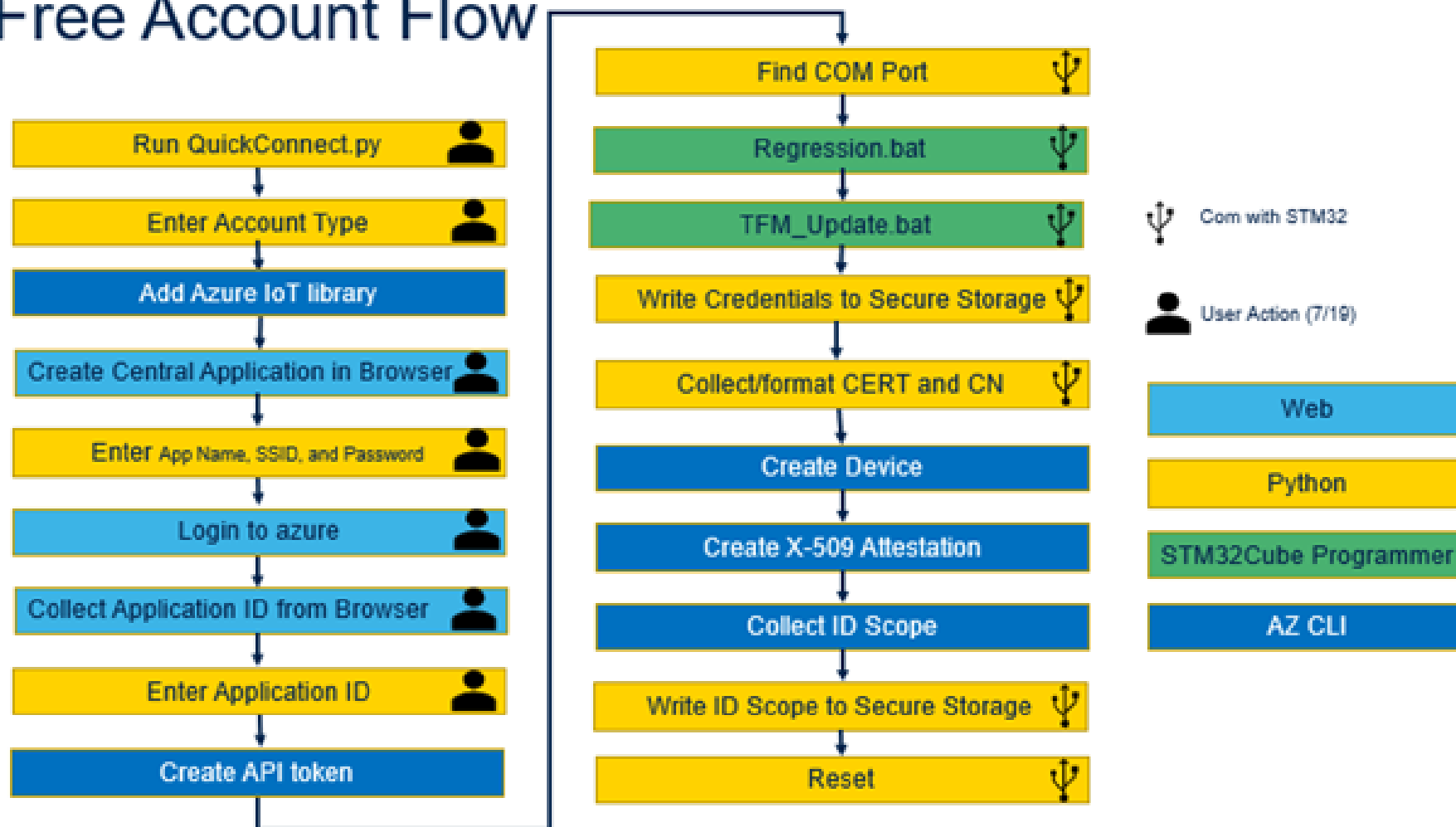
B-U585I-IOT02A



IoT Central Application

# Quick Connect Flow

## Free Account Flow



# Connect your board

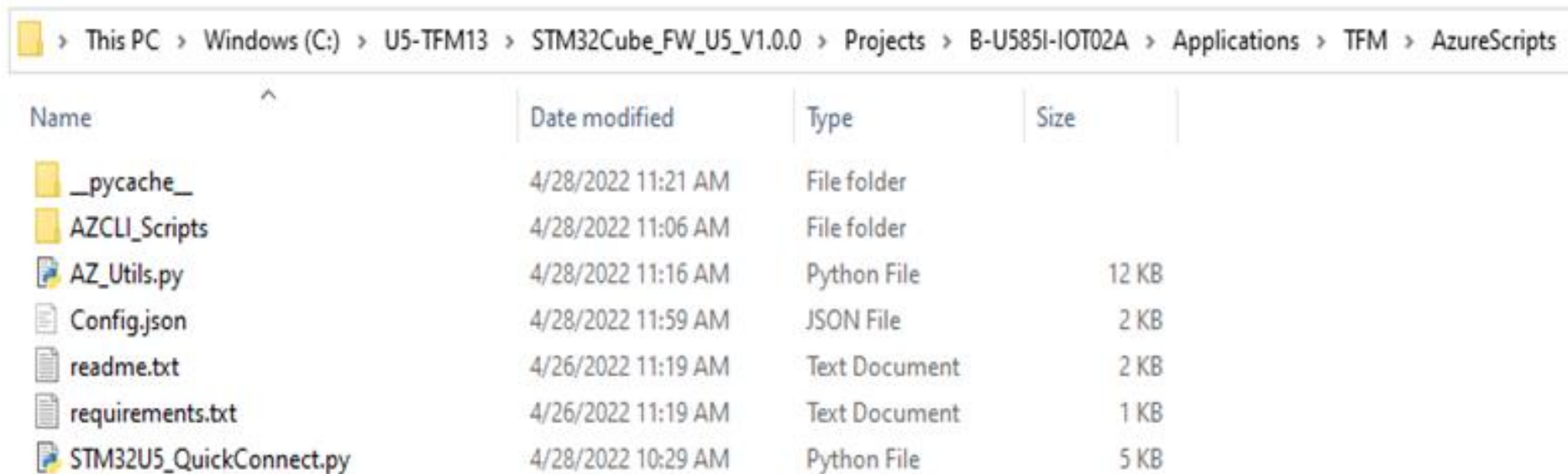
- Connect your board to the PC





# Step 1: Running Quick Connect Script

- Navigate to C:\U5-TFM\STM32Cube\_FW\_U5\_V1.1.1\Projects\B-U585I-IOT02A\Applications\TFM\AzureScripts

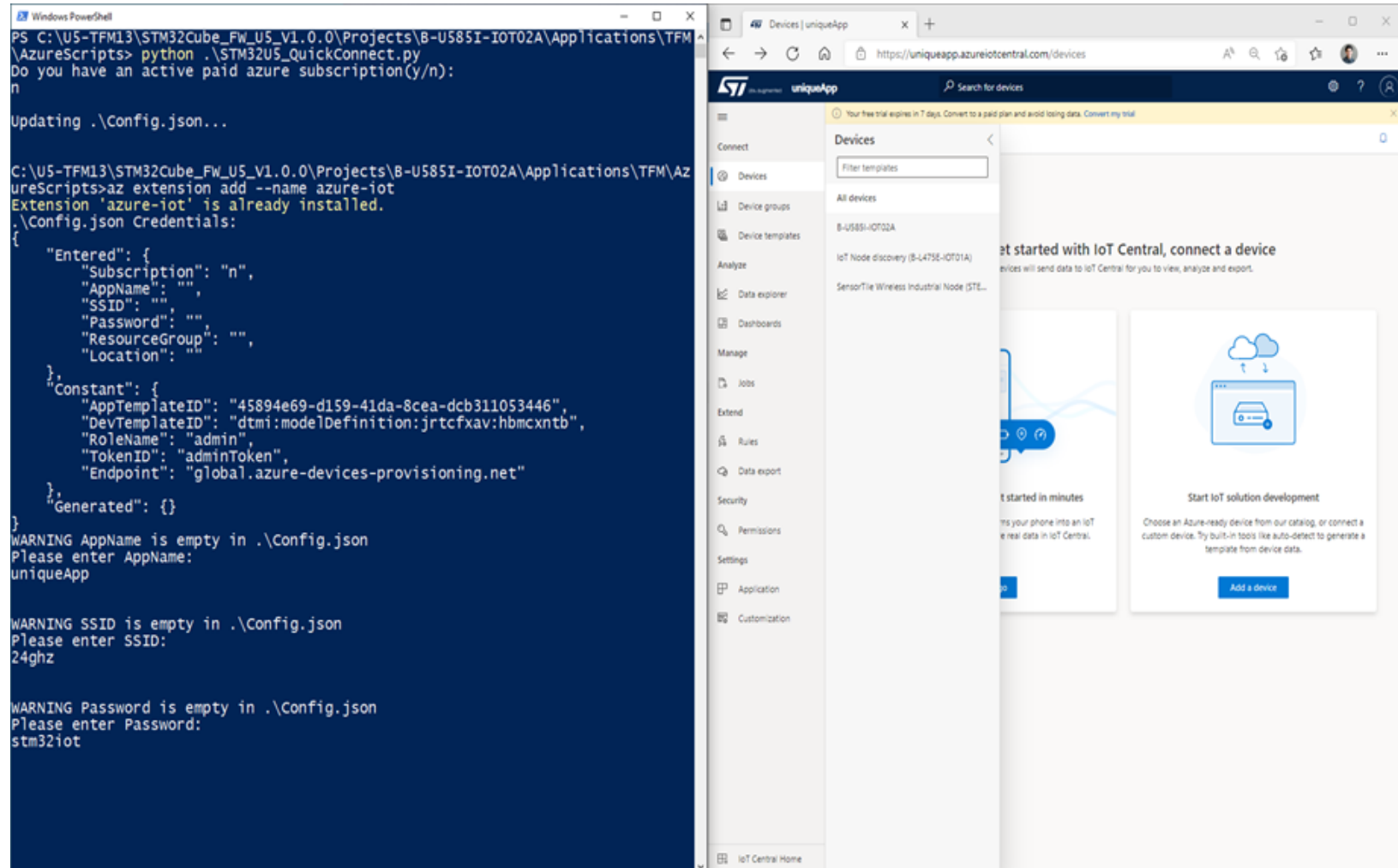


This PC > Windows (C:) > U5-TFM13 > STM32Cube_FW_U5_V1.0.0 > Projects > B-U585I-IOT02A > Applications > TFM > AzureScripts			
Name	Date modified	Type	Size
_pycache_	4/28/2022 11:21 AM	File folder	
AZCLI_Scripts	4/28/2022 11:06 AM	File folder	
AZ_Utils.py	4/28/2022 11:16 AM	Python File	12 KB
Config.json	4/28/2022 11:59 AM	JSON File	2 KB
readme.txt	4/26/2022 11:19 AM	Text Document	2 KB
requirements.txt	4/26/2022 11:19 AM	Text Document	1 KB
STM32U5_QuickConnect.py	4/28/2022 10:29 AM	Python File	5 KB

# Step 6: Enter Wi-Fi Credentials

SSID: **st\_iot\_demo**

PASSWORD: **stm32u585**



The image shows a Windows PowerShell terminal window on the left and the Azure IoT Central web interface on the right.

**PowerShell Terminal:**

```
PS C:\U5-TFM13\STM32Cube_FW_U5_V1.0.0\Projects\B-U585I-IOT02A\Applications\TFM\AzureScripts> python .\STM32U5_QuickConnect.py
Do you have an active paid azure subscription(y/n):
n
Updating .\Config.json...

C:\U5-TFM13\STM32Cube_FW_U5_V1.0.0\Projects\B-U585I-IOT02A\Applications\TFM\AzureScripts>az extension add --name azure-iot
Extension 'azure-iot' is already installed.
.\Config.json Credentials:
{
  "Entered": {
    "Subscription": "n",
    "AppName": "",
    "SSID": "",
    "Password": "",
    "ResourceGroup": "",
    "Location": ""
  },
  "Constant": {
    "AppTemplateID": "45894e69-d159-41da-8cea-dcb311053446",
    "DevTemplateID": "dtmi:modelDefinition:jrtcfxav:hbmctxntb",
    "RoleName": "admin",
    "TokenID": "adminToken",
    "Endpoint": "global.azure-devices-provisioning.net"
  },
  "Generated": {}
}
WARNING AppName is empty in .\Config.json
Please enter AppName:
uniqueApp

WARNING SSID is empty in .\Config.json
Please enter SSID:
24ghz

WARNING Password is empty in .\Config.json
Please enter Password:
stm32iot
```

**Azure IoT Central Web Interface:**

The browser window shows the 'Devices' page of the Azure IoT Central portal. The URL is <https://uniqueapp.azureiotcentral.com/devices>. The left sidebar contains navigation options: Connect, Devices, Device groups, Device templates, Analyze, Data explorer, Dashboards, Manage, Jobs, Extend, Rules, Data export, Security, Permissions, Settings, Application, and Customization. The main content area displays a 'Filter templates' search bar and a list of device templates, including 'B-U585I-IOT02A', 'IoT Node discovery (B-U4755-IOT01A)', and 'SensorTile Wireless Industrial Node (ST...)'. A yellow banner at the top indicates a 7-day free trial. Below the templates, there are two cards: 'Get started in minutes' and 'Start IoT solution development', both with 'Add a device' buttons.

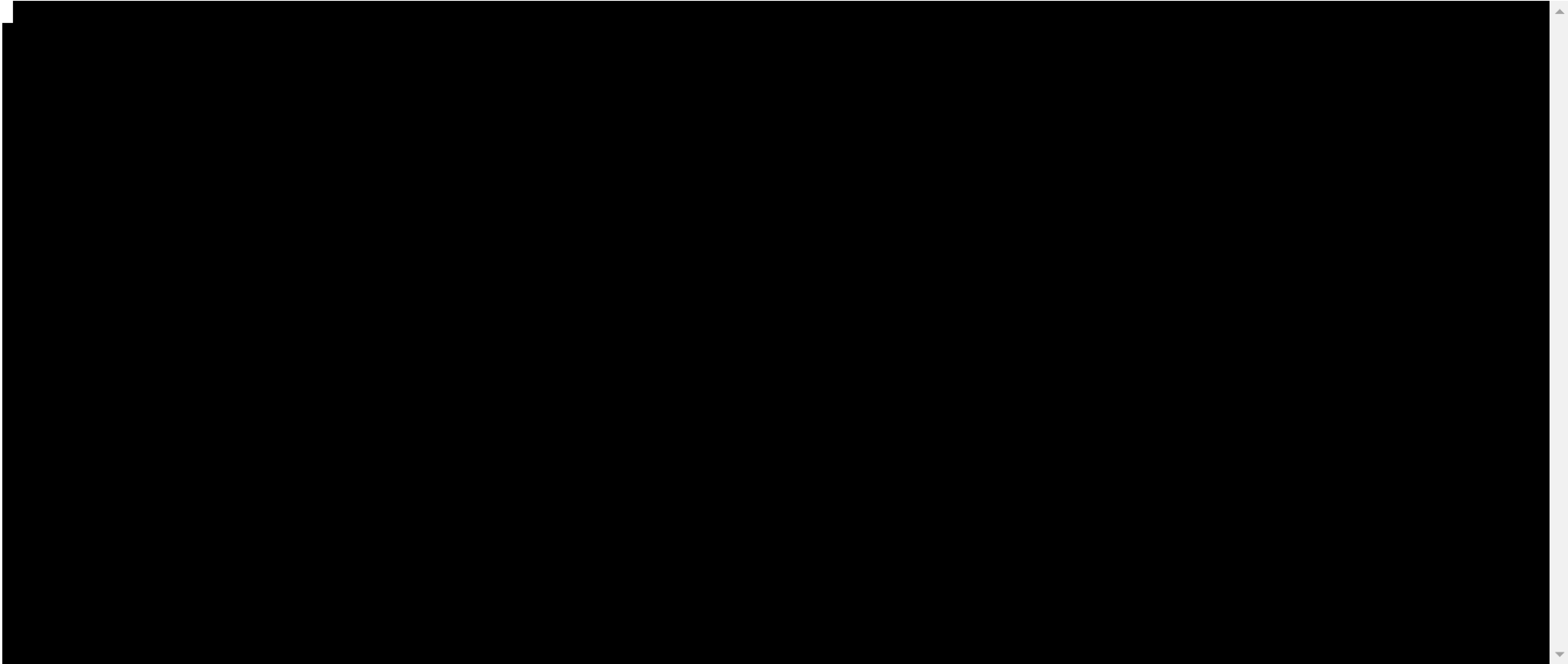
# Configuration File: Config.json

```
{ Config.json X
C: > STM32CubeExpansion_Cloud_AZURE_V2.0.0_Modified > Projects > B-U585I-IOT02A > Applications > TFM_Azure_IoT > AzureScripts > {} Config.json > ...
1  {
2    "Entered": {
3      "Subscription": "n",
4      "AppName": "custom-2g9uib7cdfe",
5      "SSID": "st_iot_demo",
6      "Password": "stm32u585",
7      "ResourceGroup": "",
8      "Location": ""
9    },
10   "Constant": {
11     "AppTemplateID": "",
12     "DevTemplateID": "",
13     "RoleName": "admin",
14     "TokenID": "adminToken",
15     "Endpoint": "global.azure-devices-provisioning.net"
16   },
17   "Generated": {
18     "AppID": "6d73bd89-3ff5-468c-84ad-e62d04c32ea2",
19     "APIToken": "SharedAccessSignature sr=6d73bd89-3ff5-468c-84ad-e62d04c32ea2&sig=QEDIi5RAmx2DXTk9ZrYPSiJqGr
20     "Cert": "MIIBmTCCAT+gAwIBAgILAgnwK0Fa1CrCATkwCgYIKoZIZj0EAwIwTzELMAkGA1UEBhMCTkwxHjAcBgNVBAoMFVNUTWljcm91
21     "RegistrationID": "eval3-0209F02B415AD42AC20139",
22     "IDScope": "0ne0077AF13"
23   }
24 }
```

# Web Based Terminal Emulator:

<https://googlechromelabs.github.io/serial-terminal/>

Port:   Baud rate:  Data bits:  Parity:  Stop bits:  ☐ Hardware flow control ☐  
Local echo ☐ Flush on enter ☐ Convert EOL ☐ Automatically connect

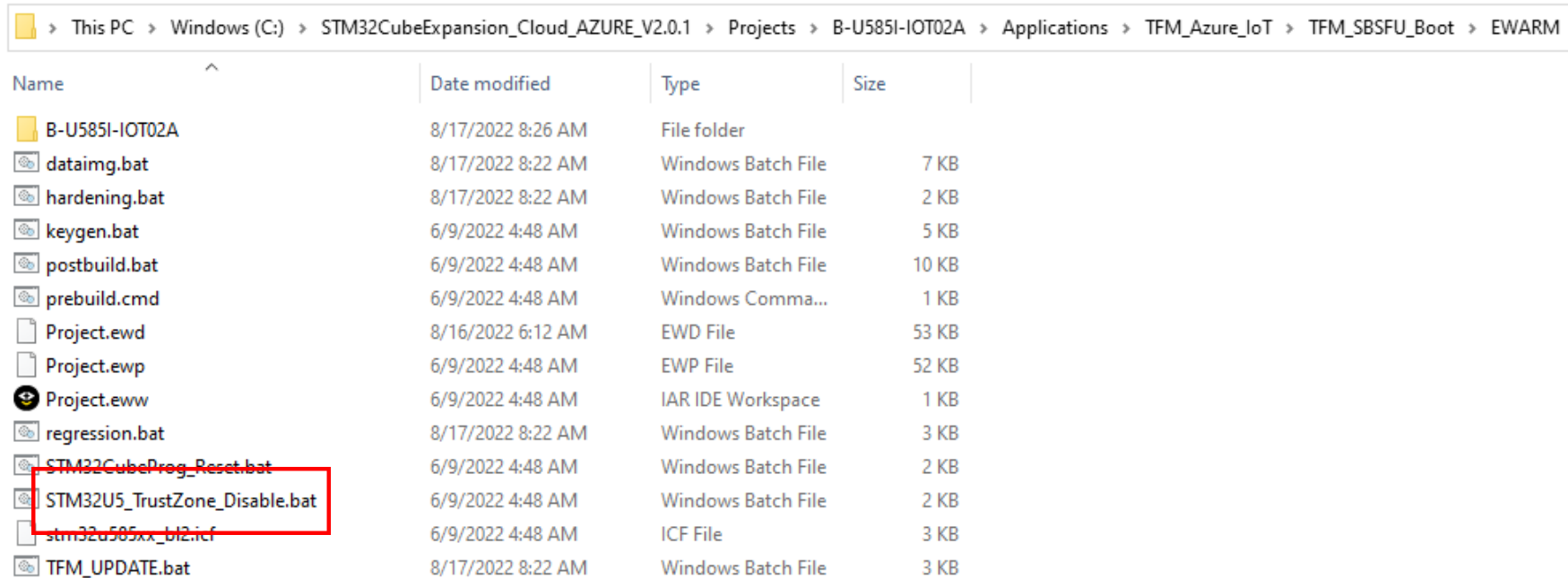


# Welcome Microsoft for Cloud Hands-On

# Option Byte Reset

# Disabling Trust Zone

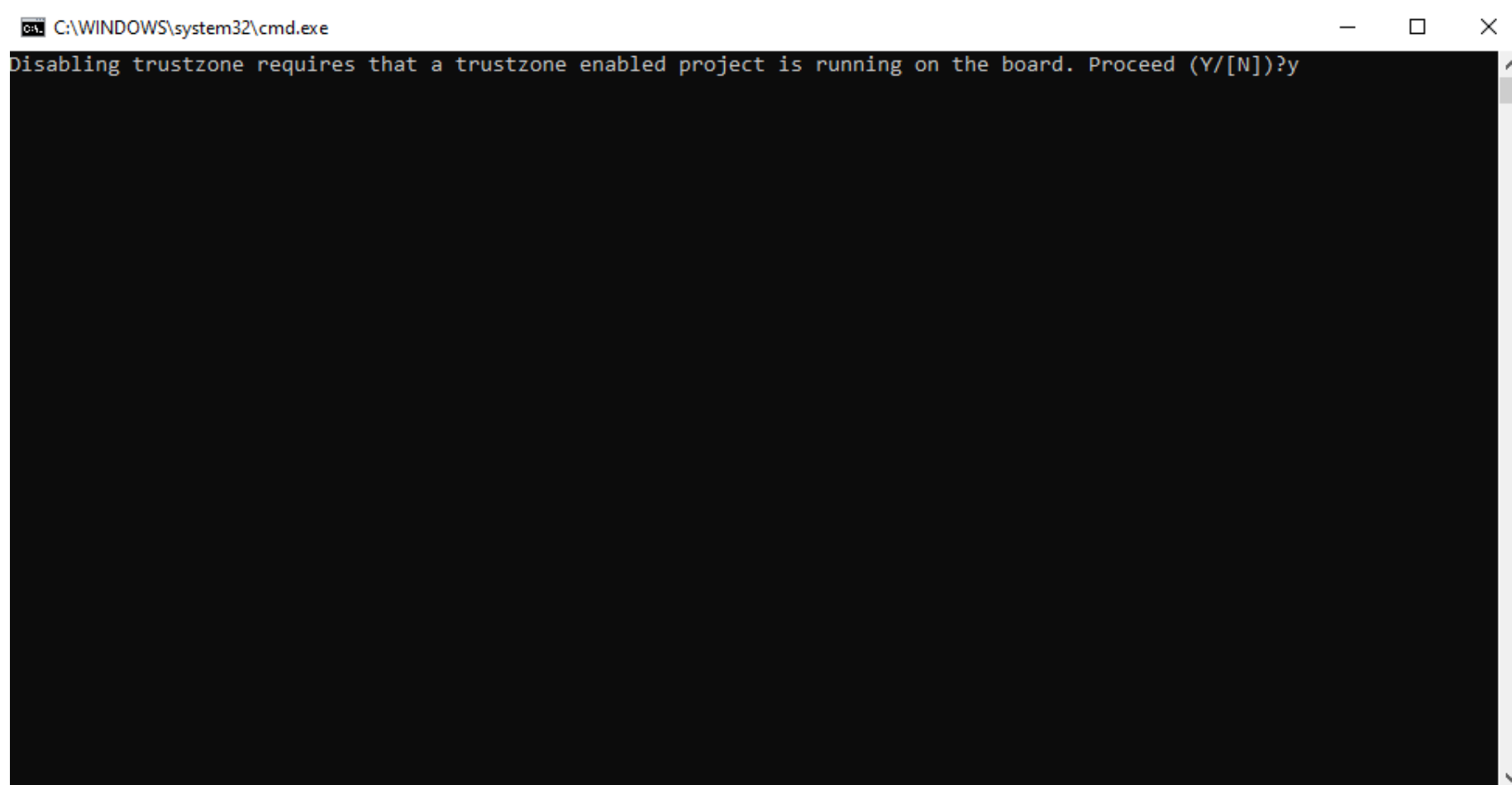
- Navigate to TFM\_Azure\_IoT\TFM\_SBSFU\_Boot\EWARM
- Double Click: STM32U5\_TrustZone\_Disable.bat



Name	Date modified	Type	Size
B-U585I-IOT02A	8/17/2022 8:26 AM	File folder	
dataimg.bat	8/17/2022 8:22 AM	Windows Batch File	7 KB
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keygen.bat	6/9/2022 4:48 AM	Windows Batch File	5 KB
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STM32U5_TrustZone_Disable.bat	6/9/2022 4:48 AM	Windows Batch File	2 KB
stm32u585xx_b12.icf	6/9/2022 4:48 AM	ICF File	3 KB
TFM_UPDATE.bat	8/17/2022 8:22 AM	Windows Batch File	3 KB

# Disabling Trust Zone

- Enter 'y' in to CMD window prompt:



A screenshot of a Windows Command Prompt window. The title bar shows the path 'C:\WINDOWS\system32\cmd.exe'. The main text area is black with white text. The first line of text reads: 'Disabling trustzone requires that a trustzone enabled project is running on the board. Proceed (Y/[N])?y'. The 'y' at the end of the line indicates that the user has entered 'y' to proceed with disabling the Trust Zone.



# Disabling Trust Zone

C:\WINDOWS\system32\cmd.exe

```
Device name : STM32U575/STM32U585
Flash size  : 2 MBytes
Device type  : MCU
Device CPU   : Cortex-M33
BL Version   : 0x92
Debug in Low Power mode enabled
```

UPLOADING OPTION BYTES DATA ...

```
Bank      : 0x00
Address    : 0x40022040
Size       : 36 Bytes
```

100%

```
Bank      : 0x01
Address    : 0x40022068
Size       : 8 Bytes
```

100%

PROGRAMMING OPTION BYTES AREA ...

```
Bank      : 0x00
Address    : 0x40022040
Size       : 36 Bytes
```



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