Getting Started for Direct-connected device

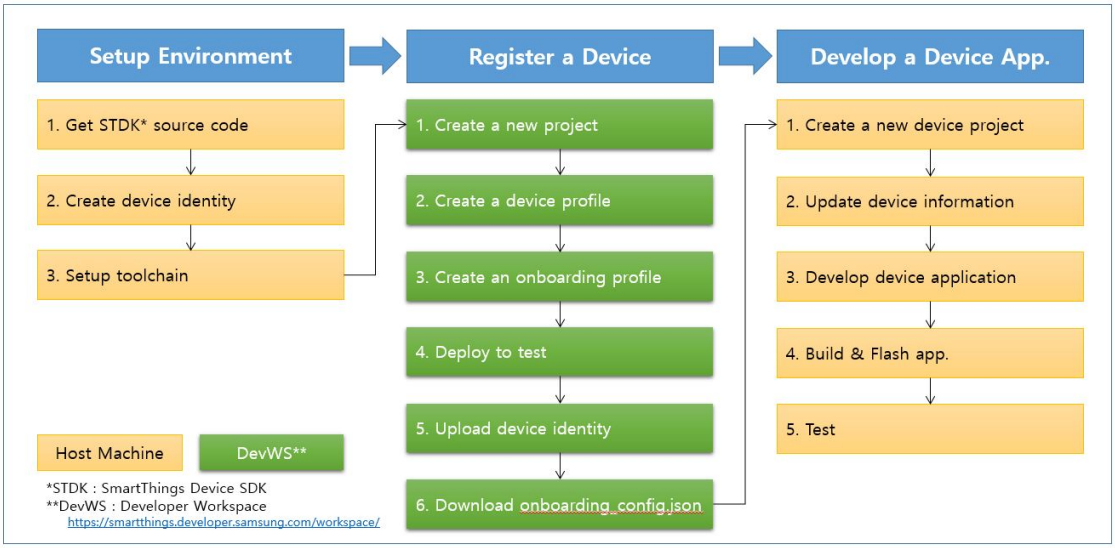
Direct-connected devices are Wifi enabled devices that use the SmartThings could as their primary cloud infrastructure. Your device will use the MQTT protocol for communication.

This article demonstrates how to integrate a direct-connected device with SmartThings.

Workflow

When developing a new direct-connected device application with SmartThings Device SDK (STDK for short), you will progress through the following steps.

- Setup Environment
- Register a Device
- Develop a Device Application



Setup Environment

The first thing you need to do is set up your programming environment.

Get STDK source code

There are two git repositories for working with the SmartThinks SDK. One git repository has the core Internet of Things (IoT) library while the second git repository has example device applications.

- IoT Core Library
- Examples

Download st-device-sdk-c-ref

You can chose to only download the `Examples` repository from git, if you have already ported your project. The `IoT core library` is downloaded as a submodule in the `examples` repository.

From the terminal, navigate to the directory you want the STDK to live and clone it using the following git command:

```
cd ~
git clone https://github.com/SmartThingsCommunity/st-device-sdk-c-ref.git
```

> **Note** : For the rest of this document, we will assume the above path (~/st-device-sdk-c-ref) is the default example source code.

You can use a script to setup a chipset SDK as follows:

```
cd ~/st-device-sdk-c-ref
./setup.sh
    Usage: ./setup.sh CHIP_NAME
- - - - - - - - - - - - - - - - - - -
    ex) ./setup.sh esp8266
    ex) ./setup.sh esp32
    ex) ./setup.sh rtl8710

./setup.sh esp8266                      # ./setup.sh {chip_name}
```

Create device identity

In order for your IoT device to connect to the SmartThings Cloud Server, there are authentication data files required.

Open a terminal window and run the following "stdk-keygen" command to create Device Identity

```
$ cd ~/st-device-sdk-c-ref/iot-core/tools/keygen/linux
$ ./stdk-keygen -help
usage: stdk-keygen [-t ed25519] [-s serial_number] [-f firmware_version]
$
$ ./stdk-keygen -s cc50e309dcd0 -f FW20191003
Generating ed25519 keypair

Secret key 'ed25519.seckey' (44 bytes)
tfoa74tLWvNLl+shUzg6CoClKWCeds8BjImkk5rnv14=
Public key 'ed25519.pubkey' (44 bytes)
GZH1KwoXuSJrOqdGKoRrADbze0rWqluRTXP4SPFvSrc=

For Developer Workspace,

Please cut the below public key and paste it on Developer Workspace.
-------------------- 8< --------------------
GZH1KwoXuSJrOqdGKoRrADbze0rWqluRTXP4SPFvSrc=
-------------------- >8 --------------------
```

Copy the value between the -------------------- 8< -------------------- and -------------------- >8 -------------------- when you run the command on your computer. You will need to upload that value to the SmartThings Cloud server via Developer Workspace during the next phase.

Setup toolchain

You must setup a toolchain according to each chipset you selected.

Example for ESP8266 :

For additional information see the following git repositories.

- *ESP8266 RTOS Example*

- *ESP8266 Docs*

ESP8266 supports multiple host environments including Windows, Linux, and macOS. Based on experience, compile times are significantly faster on Linux but it is up to you which environment you prefer to use.

1. *Install Prerequisites*

   Get the following packages :

   ```
   sudo apt-get install gcc git wget make libncurses-dev flex bison gperf
   python python-pip python-setuptools python-serial python-cryptography
   python-future python-pyparsing python-pyelftools
   ```

   > ***Note :***
   >
   > *Some older Linux distributions may be missing some of the Python packages listed above.*
   >
   > *Also note pyserial version 2.x is not supported by ESP-IDF.*

2. *Setup Toolchain*

   Get the ESP8266 toolchain for Linux, available on the Expressif website:

   - *64-bit Linux*
   - *32-bit Linux*

   Once the file is downloaded, extract it in the ~/esp directory.

   ```
   mkdir -p ~/esp
   cd ~/esp
   tar -xzf ~/Downloads/xtensa-lx106-elf-linux64-1.22.0-92-g8facf4c-
   5.2.0.tar.gz
   ```

   The above command places the files in the ~/esp/xtensa-lx106-elf/ directory.

   According to the original ESP8266 guideline, you will need to add it to your PATH environment variable in ~/.profile file. But If you installed the toolchain along the step above, it is not necessary. Because that path is exported in the build script.

Register a Device

Now that the environment is setup, you need to register a device.

First, please sign in to the Developer Workspace.

Create a new project

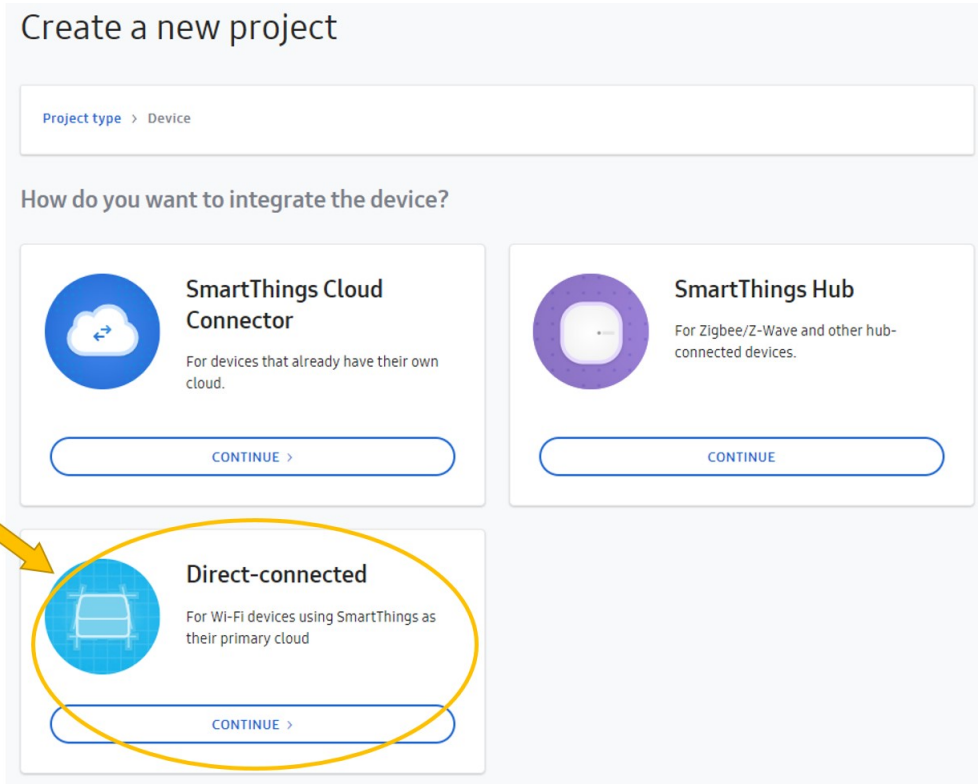
Select Direct-connected device.

Enter a name for the project, and then press "CREATE PROJECT" button to create a direct-connected device project on the SmartThings Cloud Server,

Create a device profile

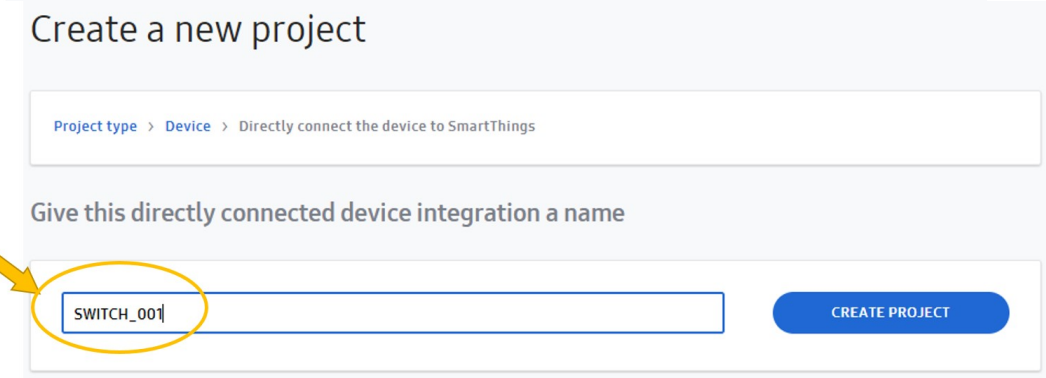
A device profile contains the components, capabilities, and metadata (ID, name, etc.) that defined in a SmartThings IoT device.

Click the "GO TO DEVICE PROFILE" and then, enter the all remaining information required.

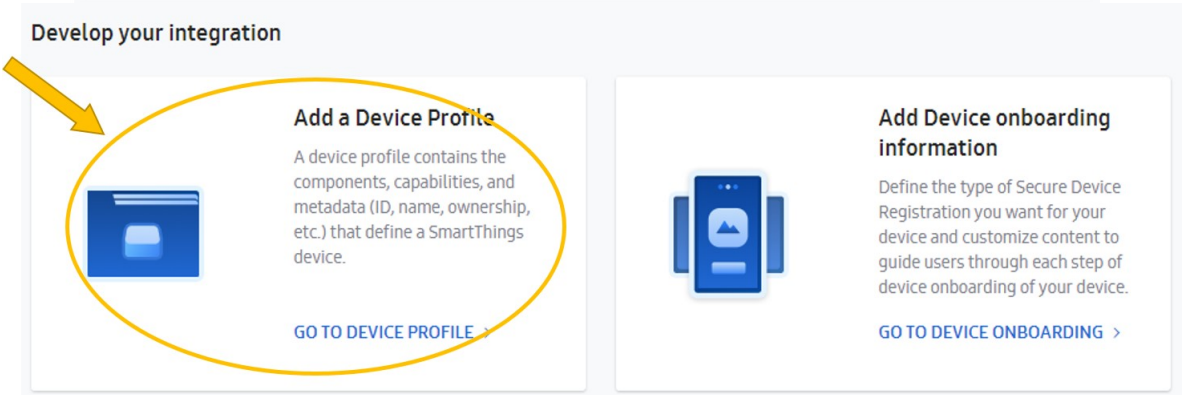


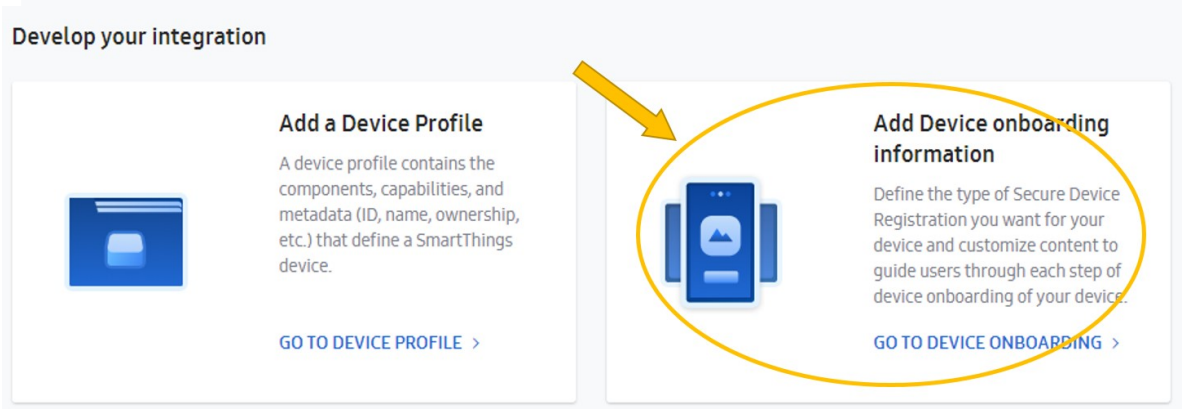
Create a device onboarding profile

Click the "GO TO DEVICE ONBOARDING" and then, enter the all remaining information required.



Deploy to test





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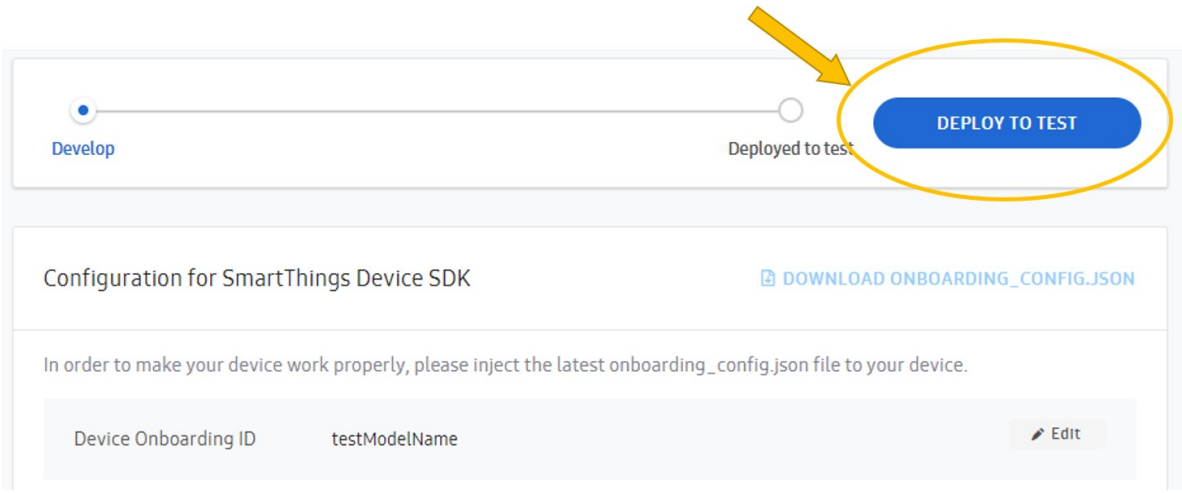
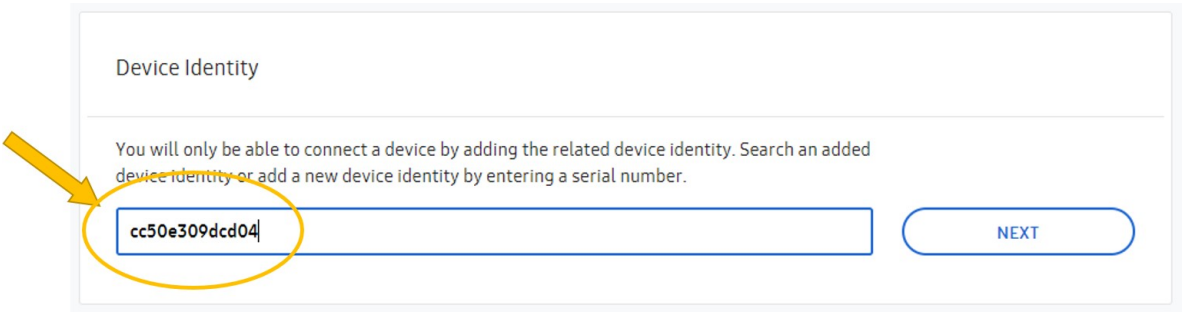
You can publish it on the SmartThings catalog server. And then you will be able to access your device in the SmartThings app.



Upload device identity

This step uploads device identity data generated in the first phase.

Enter the serial number.



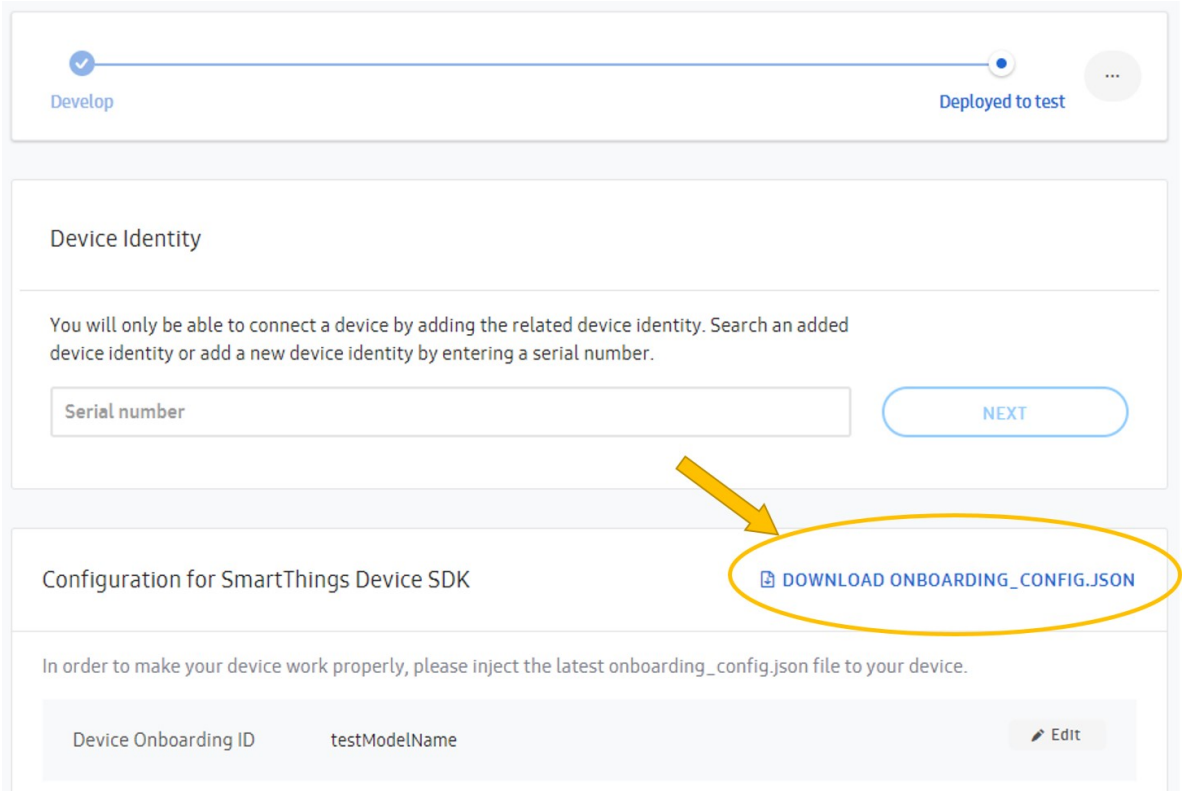
Paste the public key that copied from the first phase in the Public Key value box that appears

And then, click ADD button.

Download onboarding_config.json

This is the information that the IoT device must have in order to connect to the SmartThings Cloud Server.

Please download it.



Develop a device application

You have the environment set up and you have registered a device, so now it is time to create a new device project.

Create a new device project

An easy way to get started is to branch off of one of the example projects provided in the git repository. We will use the "st_switch" application from the STDK directory here.

```
# Full path of the ESP8266
~/st-device-sdk-c-ref/apps/esp8266/st_switch/
```

Update device information

Your IoT device needs two pieces of information before connecting to the SmartThings Cloud Server:

- Device Identity
- onboarding_config.json

1. Device Identity

   Device identity provides data that needs to be sent for authentication with the server. There are two different packets of information, one for the individual developer and one for the manufacturer.

   - Individual developer

     All of the data below should be included in the device_info.json file in the `main` directory of the device application.

     If you create a device identity with a command with an option like `./stdk-keygen -s cc50e309dcd0 -f FW20191003`, You can get the ready-to-use device_info.json file directly.

```
$ ls
stdk-keygen
$ ./stdk-keygen -s cc50e309dcd0 -f FW20191003
$ ls
ed25519.pubkey  ed25519.seckey  output_cc50e309dcd0  stdk-keygen
$ cd output_cc50e309dcd0
$ls
device_info.json
$ vi device_info.json

# Example of device_info.json
{
    "deviceInfo": {
        "firmwareVersion": "FW20191003",
        "privateKey": "tfoa74tLWvNLl+shUzg6CoClKWCeds8BjImkk5rnv14=",
        "publicKey": "GZH1KwoXuSJrOqdGKoRrADbze0rWqluRTXP4SPFvSrc=",
        "serialNumber": "cc50e309dcd0"
    }
}
```

- Manufacturer

  For the manufacturer, we cannot place the device identity files in the source code because it is impossible to build and flash every time for each device. To solve this problem, the production level application should store device identity files for each device in a secure location during the manufacturing process. For example, device identity data will be flashed into the SmartThings Non-Volatile memory location.

  [For ED25519]

Flashed items	Type	Description	Examples
PKType	data	PubKey Algorithm type	ED25519
CACert	file	Server CA Certificate	root.crt.pem
PublicKey	file	Client (= Device) Public key	device.pubkey.b64
PrivateKey	file	Client (= Device) Private key	device.seckey.b64
SerialNum	data	Device Serial Number	cc50e309dcd0

2. onboarding_config.json

   Place the onboarding_config.json file created during the device registration phase in the `main` directory of device application.

   Example

```
# Location for ESP8266
~/st-device-sdk-c-ref/apps/esp8266/st_switch/main/onboarding_config.json
```

```
# Example of onboarding_config.json
{
  "onboardingConfig": {
    "deviceOnboardingId": "STDK",
    "mnId": "fIJ3",
    "setupId": "001",
```

```
    "vid": "STDK_SMARTLAMP_0001",
    "deviceTypeId": "Switch",
    "ownershipValidationTypes": [
      "BUTTON"
    ],
    "identityType": "ED25519"
  }
}
```

- deviceOnboardingId : It is a prefix to be used for the SSID of Soft-AP during Easy-setup process. This value comes from 'Product name' when doing `Create a device information` on the DevWS.
  - Example of SSID : STDK[x28d]
- mnId : Manufacturer ID. A unique four-letter ID assigned to SmartThings developers (individual MNID) or enrolled organizations (company MNID) that can be viewed at My Page > MNID.
- setupId : a unique three-digit number. This value comes from 'Device onboarding ID' when doing `Create a device onboarding profile` on the DevWS.
- vid : An alphanumeric identifier for your device. This value comes from 'VID(Vendor ID)' when doing `Create a device profile` on the DevWS.
- deviceTypeId : This determines the device's icon and default UI layout in the SmartThings app. This is the value you selected from the value given as a list when doing `Create a device profile`.
- ownershipValidationTypes : This is the type of ownership confirmation used during onboarding process. There are four supported types
  - JUSTWORKS
  - BUTTON
  - PIN
  - QR
- identityType : A unique certificate or public key pair type used to authenticate a device on SmartThings Cloud Server. You can choose between
  - ED25519
  - X.509

Develop device application

A device application is developed using the APIs provided by the IoT Core Library. We recommend reuse of the pre-supplied sample applications, like st_switch. This allows for rapid development as you begin to develop your new device. Please refer to the API references related to the IoT core library as shown:

- connection management
  - st_conn_init()
  - st_conn_set_noti_cb()
  - st_conn_start()
  - st_conn_cleanup()
  - st_conn_ownership_confirm()
- capability management
  - st_cap_handle_init()

- st_cap_cmd_set_cb()
  st_cap_attr_create_int()
- st_cap_attr_create_number()
- st_cap_attr_create_string()
- st_cap_attr_create_string_array()
- st_cap_attr_free()
- st_cap_attr_send()

Main function example for ESP8266 :

```
/**
SmartThings Device Kit(STDK) aims to make it easier to develop IoT devices by
providing
additional IoT Core Library to the existing chip vendor SW Architecture.

That is, you can simply develop a basic application by just calling the APIs
provided by IoT Core Library like below. Currently, IoT Core Library offers 13
APIs.

//create an iot context
1. st_conn_init();

//create a handle to process capability
2. st_cap_handle_init();

//register a callback function to process capability command when it comes from
the SmartThings Server.
3. st_cap_cmd_set_cb();

//needed when it is necessary to keep monitoring the device status
4. user_defined_task()

//process on-boarding procedure. There is nothing more to do on the app side
than call the API.
5. st_conn_start();
*/

void app_main(void)
{

    unsigned char *onboarding_profile = (unsigned char *)
onboarding_profile_start;
    unsigned int onboarding_profile_len = onboarding_profile_end -
onboarding_profile_start - 1;
    unsigned char *device_info = (unsigned char *) device_info_start;
    unsigned int device_info_len = device_info_end - device_info_start - 1;
    IOT_CAP_HANDLE *handle = NULL;
    int iot_err;

    // 1. create an iot context
    ctx = st_conn_init(onboarding_profile, onboarding_profile_len, device_info,
device_info_len);
    if (ctx != NULL) {
      iot_err = st_conn_set_noti_cb(ctx, cap_switch_noti_cb, NULL);
      if (iot_err)
        printf("fail to set notification callback function\n");
```

```
    // 2. create a handle to process capability
    // implement init_callback function (cap_switch_init_cb)
    handle = st_cap_handle_init(ctx, "main", "switch", cap_switch_init_cb,
NULL);

    // 3. register a callback function to process capability command when it
comes from the SmartThings Server
    // implement callback function (cap_switch_cmd_off_cb)
    iot_err = st_cap_cmd_set_cb(handle, "off", cap_switch_cmd_off_cb, NULL);
    if (iot_err)
      printf("fail to set cmd_cb for off\n");

    // implement callback function (cap_switch_cmd_on_cb)
    iot_err = st_cap_cmd_set_cb(handle, "on", cap_switch_cmd_on_cb, NULL);
    if (iot_err)
      printf("fail to set cmd_cb for on\n");

    } else {
      printf("fail to create the iot_context\n");
    }

    // 4. needed when it is necessary to keep monitoring the device status
    xTaskCreate(smartswitch_task, "smartswitch_task", 2048, (void *)handle, 10,
NULL);

    // 5. process on-boarding procedure. There is nothing more to do on the app
side than call the API.
    st_conn_start(ctx, (st_status_cb)&iot_status_cb, IOT_STATUS_ALL, NULL,
NULL);

}
```

Build & Flash app

Go to the root directory of the STDK and execute the build script(build.sh) with the below parameter.

```
cd ~/st-device-sdk-c-ref/
./build.sh esp8266 st_switch             # ./build.sh {chip_name}
{app_directory}
```

To build a user binary, please use “./usr_build.sh” instead of “./build.sh”.

After compiling, you should see a result similar to below.

```
# Example for ESP8266
|-- output
| `-- iotcore_st_switch_20190719_771f5140   #
iotcore_'project_name'_'date'_'commit_id'
| |-- address_info.txt
| |-- bootloader.bin
| |-- debug
| |-- partition.bin
| `-- st_switch_demo.bin
```

You can now execute the following command to flash the entire project (app, bootloader, and init data bin) to a new chip.

```
cd ~/st-device-sdk-c-ref/
./build.sh esp8266 st_switch flash
```

The serial port needs to be matched to the computer environment for serial port flashing. For example, in ESP8266 the settings for serial port flashing can be configured with `make menuconfig`. If the serial port setting does not match your environment, please execute the following:

```
# Example for ESP8266
cd ~/st-device-sdk-c-ref/apps/esp8266/st_switch
make menuconfig
```

You don't need to run ‘./build.sh esp8266 st_switch’ before running “./build.sh esp8266 st_switch flash”, this will automatically rebuild anything which needs it.

Test

The SmartThings App should be used to control an IoT device that is running with the SmartThings Cloud server. Go to Google Play or the iOS App Store and download the SmartThings app on your phone.

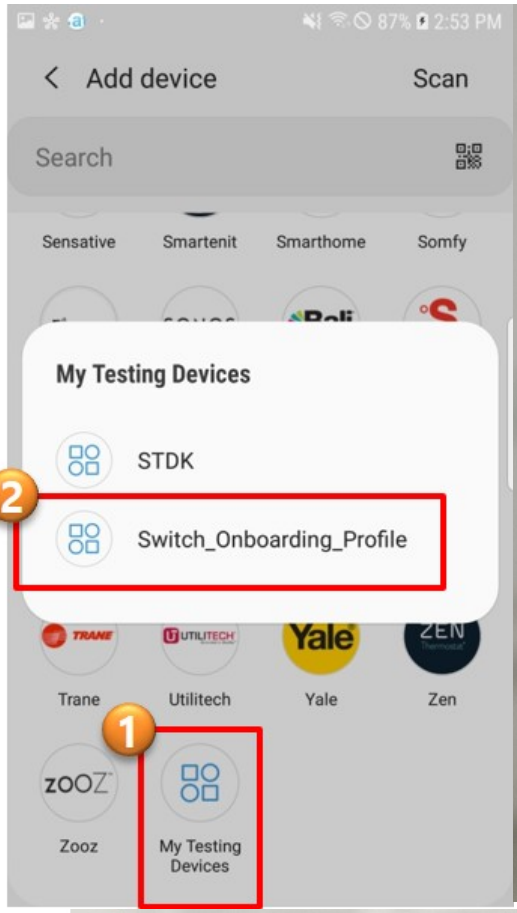
1. Reset the Device

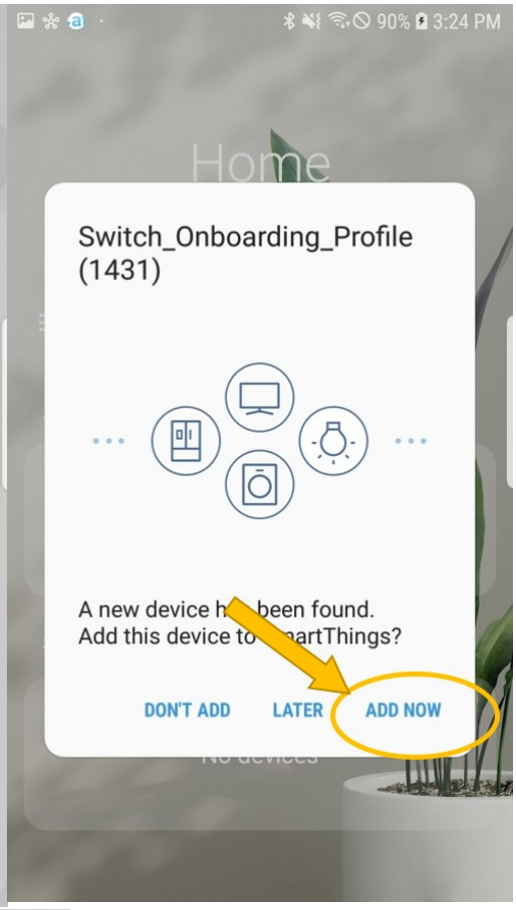
   Just push the reset button of device or run the command below in the console window.

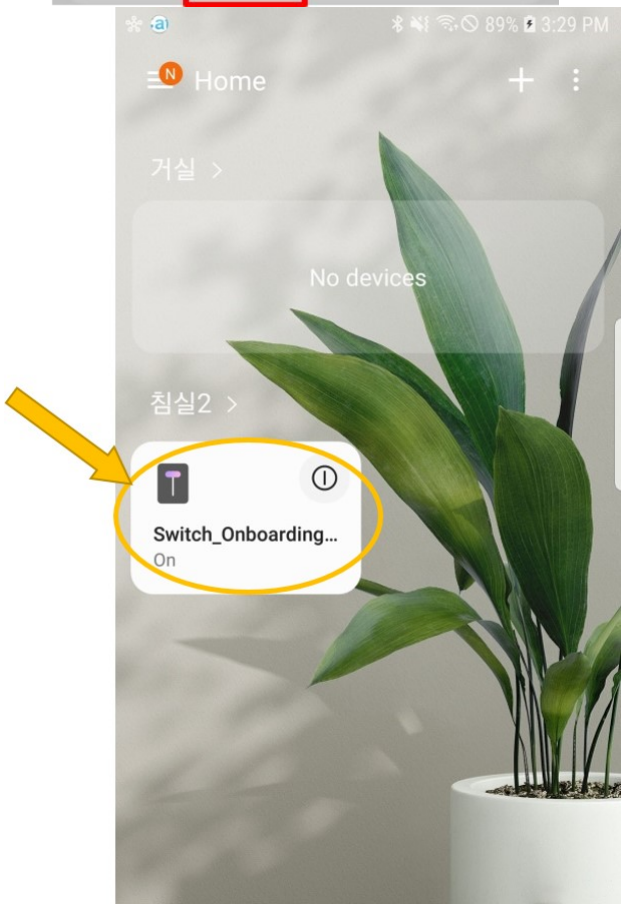
   ```
   cd ~/st-device-sdk-c-ref
   ./build.sh esp8266 st_switch monitor
   ```

2. Launch SmartThings App and select the onboarding profile name of your test device.
3. Add your test device which was executed above step 1.
4. Control & Monitor a device

   Now that your device is on the SmartThings App you can control and monitor your device. Execute your test scripts to make sure the App is working the way you think it should.


87% 2:53 PM
Add device
Scan
Search
Sensative
Smartenit
Smarthome
Somfy
My Testing Devices
STDK
Switch_Onboarding_Profile
2
Trane
Utilitech
Yale
Zen
1
Zooz
My Testing Devices


90% 3:24 PM
Home
Switch_Onboarding_Profile
(1431)
A new device h been found.
Add this device to artThings?
DON'T ADD
LATER
ADD NOW


89% 3:29 PM
Home
거실
No devices
침실2
Switch_Onboarding...
On