



Software Requirements and Permissions

T4H RCU SETUP APPLICATION



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Reviewer:	
Version nº:	1.0
Publication date:	02.01.2024

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1. Acronyms and Abbreviations

API	Application Programming Interface
ATT	Attribute Protocol
BLE	Bluetooth Low Energy
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
DAS	Display Assisted Setup
EDID	Extended Display Identification Data
FIFO	Firs In First Out (buffer)
GAP	Generic Access Profile
GATT	Generic Attribute Profile
GUI	Graphical User Interface
HDMI	High-Definition Multimedia Interface
HoGP	HID over GATT Profile
IR	Infrared
IRDB	IR Database (same as UDB)
IREDD	Infrared Emitting Diode
LED	Light Emitting Diode
OAD	Over the Air Download
pnplD	Plug and Play Identification
RCU	Remote Control Unit
RF	Radio Frequency
SDK	Software Development Kit
SoC	System on Chip
SIG	Special Interest Group
STB	Set-Top Box
TI	Texas Instruments
TV	Television
UDB	Universal Data Base
UI	User Interface
UUID	Universally Unique Identifier

2. Introduction

2.1 Purpose of this document

The Software Requirements and Permissions document describes the requirements for the RCU Setup Application. The document details the requirements of the user interface, to be implemented, and the application, as well as the other system parts that are required to accomplish this.

The intended audience are all involved in implementing the DAS features contained in the RCU Setup Application, specifically the teams that need to use the Tech4Home application to design the user journey screens that involve DAS. On the lower end, the teams that are responsible for providing access to storage, EDID information, CEC information/control and BLE communication.

2.2 Edition History

Version	Status	Date	Author	Modifications
1.0	Final	02 January 2024	Rui Silva	Initial version.

3. Overview

DAS is a wizard that appears on the display and assists the user with the setup of their remote-control unit (RCU). One of the features that can be setup with the RCU Setup Application are the TV IR controls through an IRDB database (IRDB), also referred to as a Universal Database (UDB), that is stored locally in the RCU. The UDB contains the most popular ranked brands of Television from around the world.

The main goal of DAS in the RCU Setup Application, is to automate as many parts of the process as possible for the user.

DAS has the following features:

- Automatic mode
- Semi-automatic mode

The RCU Setup Application with its DAS feature, will first try to setup the remote using the automatic process. The TV IR controls are configured using a UDB Code that is linked to the Extended Display Identification Data (EDID) or Plug-and-Play Identification (pnpID) information received from the TV via the STB. EDID is a standard feature of consumer electronics that identifies the device and lists some parameters and features of the device. The EDID or pnpID to UDB Code association is defined in the UDB metadata file.

On the other hand, if the RCU Setup Application does not have the EDID information it will try to get the pnpID using Android functions; for this to be possible the STB must have a version of Android 12 (API level 31) or superior. With the EDID or pnpID information available, the RCU Setup Application can narrow down the search in the local UDB and obtain a suitable IR code to send to the RCU.

The automatic process may fail because the EDID/pnpID is not available/recognized or the IR Code set associated with it may not be the most suitable. For these cases, DAS also includes a semi-automatic mode where it can test IR code sets for each brand available in the UDB. The brand is selected manually by the user.

Tech4home will deliver the required UDB metadata file to be placed in the STB, accessible to the RCU Setup Application, as well as the IRDB file that resides in the RCU.

There are two sets of data available in the UDB metadata file, stored in the RCU. One set of data provides metadata related to TV models that is used to search for the relevant HDMI EDID data and

the other set of data is a database with an entry for each brand. For each brand there is a brand-ID, brand-name and a list of IR code sets that together cover all or most TV models for that brand.

4. RCU Setup Application Requirements

The Tech4Home RCU Setup Application needs to be able to communicate with the RCU through the BLE channel and it needs to have certain STB permissions configured to achieve this. There may possibly be some existing interfaces already defined within the customer's platform.

For the RCU Setup Application to work on the STB, it must fulfill the following requirements:

1. Android version above 12 (API Level 31).
2. Access to storage:
 - The Metadata file: T4H RCU Setup Application needs at least read access to this file.
These files need to be stored at the following location: `vendor/etc/rcusetupappdata`.

3. Android Permissions:

The system consists of two applications working in parallel, as described in 5 System Architecture. The AIDL application is responsible for communications using the T4H DAS protocol with the RCU. The other application, named RCU Setup Application, oversees the graphical user interface (GUI). For these applications to work correctly, the client or middleware integrator needs to guarantee the configuration of the necessary permissions.

The AIDL requires the following Android permissions:

- ACCESS_WIFI_STATE
- ACCESS_NETWORK_STATE
- WRITE_EXTERNAL_STORAGE
- READ_EXTERNAL_STORAGE
- RECORD_AUDIO
- MODIFY_AUDIO_SETTINGS
- BROADCAST_STICKY
- BLUETOOTH
- BLUETOOTH_CONNECT
- BLUETOOTH_ADMIN
- ACCESS_COARSE_LOCATION
- ACCESS_FINE_LOCATION
- INTERNET
- BLUETOOTH_PRIVILEGED

The RCU Setup Application requires the following Android permissions:

- ACCESS_WIFI_STATE

- ACCESS_NETWORK_STATE
- WRITE_EXTERNAL_STORAGE
- READ_EXTERNAL_STORAGE
- RECORD_AUDIO
- MODIFY_AUDIO_SETTINGS
- BROADCAST_STICKY
- BLUETOOTH
- BLUETOOTH_CONNECT
- BLUETOOTH_ADMIN
- ACCESS_COARSE_LOCATION
- ACCESS_FINE_LOCATION
- INTERNET
- WRITE_SECURE_SETTINGS
- REBOOT
- QUERY_ALL_PACKAGES

4. Device information:

- The RCU Setup Application needs access to the EDID information from the STB. The EDID file is usually captured from the HDMI interface, for this the client / middleware integrator must invoke a T4H intent with the EDID data as payload. The next image is an example on how to do this:

```
byte[] edid = {(byte)0x00, (byte)0xFF, (byte)0xFF, (byte)0xFF, (byte)0xFF, (byte)0xFF, (byte)0xFF, (byte)0x00, (byte)0x4D, (byte)0xD9, (byte)0x02, (l

Intent launchIntent = getApplicationContext().getPackageManager().getLaunchIntentForPackage("pt.multiverso.tech4homesoftwaredemo");
launchIntent.setClassName("pt.multiverso.tech4homesoftwaredemo", "pt.multiverso.tech4homesoftwaredemo.DASActivity");
launchIntent.setAction("pt.multiverso.tech4home.start_das");

if (launchIntent != null)
{
    launchIntent.putExtra("edid", new String(edid));
    startActivity(launchIntent);
    finish();
}
else
    Toast.makeText(getApplicationContext(), "Launch intent not available", Toast.LENGTH_SHORT).show();
```

Figure 1. Example Showing How To Pass EDID Information

The RCU Setup Application upon receiving the invoking intent will process it and initiate the automatic DAS method with the received EDID information.

If it is not possible to use the EDID information, the RCU Setup application will use Android functions to retrieve the brand / model of the device; the STB must have Android version 12 (API Level 31) or above. If these requirements are not fulfilled the RCU Setup Application will always run the semi-automatic flow.

5. CEC control:

- T4H RCU Setup Application cannot control this option, it is useful to disable CEC control during the execution of the application and then restore it to the previous state. Therefore, the client or the middleware integrator must control this external to the application.

6. BLE communication:

- Verify if there is a paired RCU and identify this RCU.
- Send Vendor-defined DAS protocol requests through T4H service.

The Tech4Home RCU Setup Application's callbacks shall be notified of the following events:

- Frames sent by the RCU through the T4H service.
- RCU pairing event.
- RCU pairing lost or undone event.
- Reconnection event.

5. System Architecture

The next figure exemplifies the architecture of T4H RCU Setup Application:

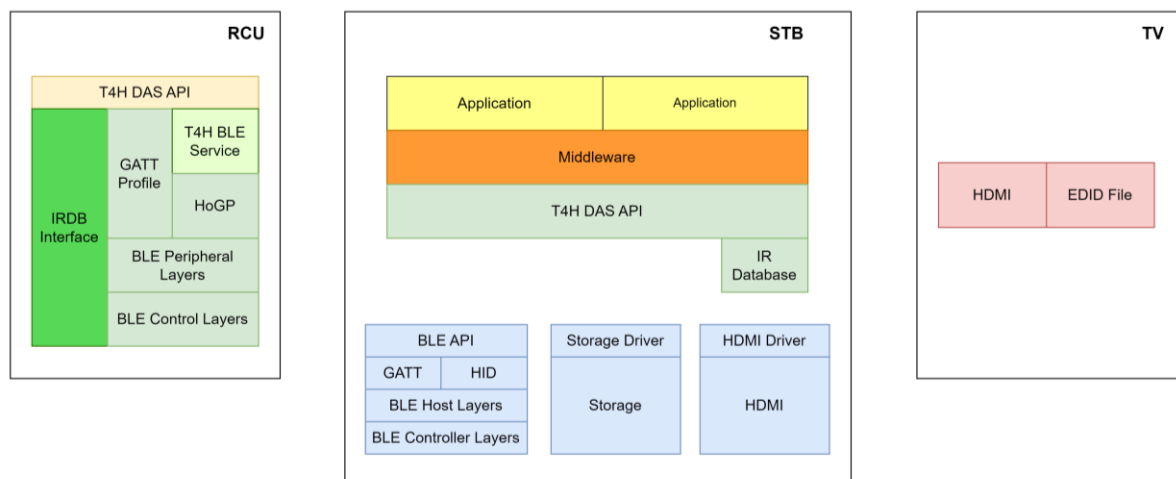


Figure 2 – RCU Setup Application System Architecture

DAS can be used to setup features on the RCU using the system's display as a user interface element. A typical use is to setup the TV IR controls in the RCU using a customer journey on the STB's UI.

The STB is the Central device that receives and sends information in different manners for all sub-systems attached, like the RCU and TV. The STB has two essential applications that interact with each other; one is related to the user interface (RCU Setup Application) and the other is responsible for communicating with the RCU using the T4H DAS protocol (AIDL Application).

In Figure 3, it is possible to see the interactions between all the essential elements of DAS. Basically, the STB is the central element of the system. If the Central obtains the EDID information from the TV device it simplifies the programming process of the RCU, otherwise the application will get the information of which device is connected via HDMI through Android functions and thereby gets the pnpID to perform the **automatic process**; this means, that the application will fetch the most suitable UDB Code Set for the brand of the TV connected and send it to the RCU.

If the device information is not available or the application cannot find any suitable Code Set, the user must use the **semi-automatic** process and manually choose the brand of their TV. The application filters the data using the brand of the TV and sends all the UDB Code Sets available in the UDB to the RCU, for the brand in question.

The RCU communicates with the STB using a proprietary T4H BLE Service in BLE GATT and obtains the UDB.

The STB searches through the IRDB Metadata file (csv) stored on the STB and sends the Code Sets to the RCU. The RCU has a compatible IRDB file (bin) stored in its flash memory and converts the number of the Code Set to IR Waveforms (Figure 3).

The IRDB Metadata file (csv) and the IRDB file (bin) must be stored on the STB. Both these files can be updated to newer versions when available; the IRDB file (bin) is to be download to the RCU.

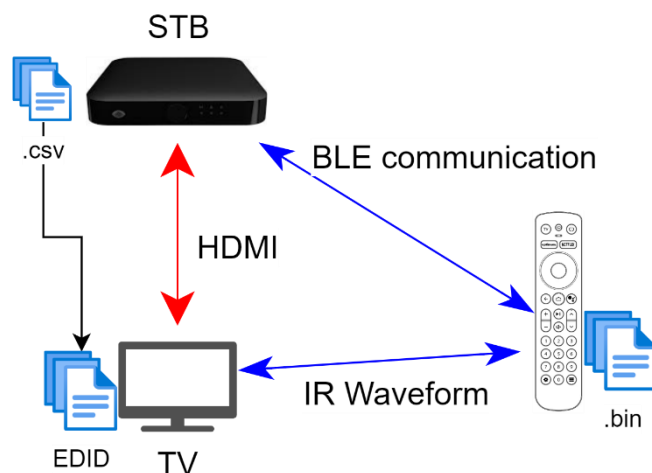


Figure 3. DAS Interactions.

On the STB, the Tech4Home application need to be able to communicate with the RCU via BLE and it needs to be able to store a context on the STB's non-volatile memory.

The Tech4Home DAS protocol is fully proprietary.

5.1 DAS triggers

The DAS processes can be triggered by a variety of events. However, these events must be processed and managed by the client and the team that are integrating the RCU Setup Application.

5.1.1 First Time Installation

First time installation is a trigger on the STB that can be given after the RCU is paired with the STB. The STB shall omit this trigger if the RCU has already triggered the process.

5.1.2 HDMI Hot Plug

The user may install a new TV. The RCU needs to be reprogrammed to be able to control this new TV. The event that may trigger the DAS TV process to restart is the plug-in of the HDMI cable. Plugging in the cable can trigger the reading of the new EDID; DAS TV may be started if the EDID is different from the one that was used when the RCU was first set-up. There is no need to trigger DAS if it is just a re-plug-in of the same TV.

5.1.3 Setup menu

The user may trigger DAS by selecting the set-up feature in the STB UI menu.

5.2 DAS Flow

DAS can be triggered by one of the trigger events as described in chapter 5.1.

In **Block 1**, DAS invites the user to start the set-up process.

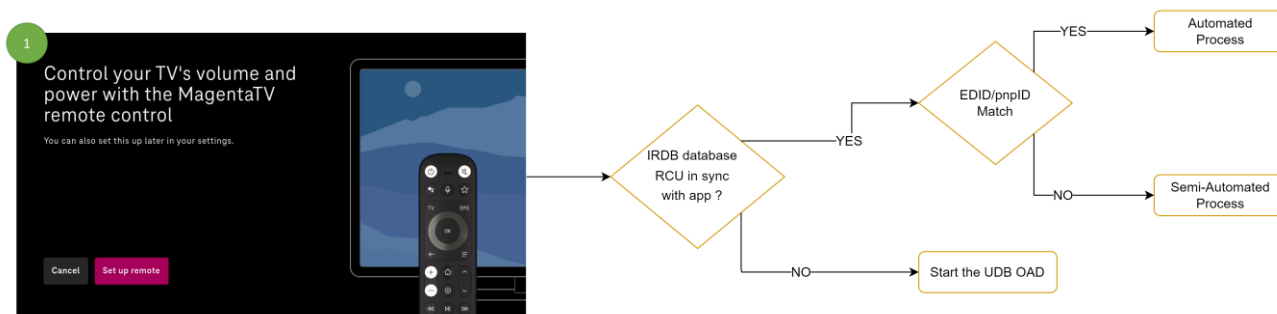


Figure 4. Block 1 : Initialise DAS

RCU Setup Application checks the following:

- RCU Setup Application will send/search the IR Codes available in the IRDB files present on the STB, these include:
 1. **UDB Metadata file** – Stored in CSV format, DAS will not be able to trigger without this file;
 2. **UDB OAD file** – Stored in BIN format. This can be used in the situation where the RCU contains a different UDB version from what is currently being used by the RCU Setup Application.

Although these files are available for download via Tech4Home's smart cloud, it is recommended to always store and use these files locally. This guarantees that the RCU Setup Application can be triggered and is not dependent on the Tech4home online status.

It is necessary that the version of the IR database of the RCU matches the IR database of the files on the STB to proceed to the next steps. If there isn't a match for any of the following reasons:

- The RCU does not have an embedded IR database.
- The version of the files on the STB is different to the version of the RCU.

then the RCU Setup Application must first perform an OAD and download the UDB OAD file to the RCU to ensure the RCU is in sync with the RCU Setup Application.

After the RCU Setup Application has verified the UDB version, it will try to retrieve the device information through the EDID or the pnpID:

- **Valid information:** the RCU Setup Application finds in the UDB Metadata files, the brand of the TV and the list of compatible Code Sets available on the RCU. RCU Setup Application triggers the **Automated-process**.
- **Invalid information:** the RCU Setup Application does not find a suitable TV Code Set in the UDB Metadata files. The RCU Setup Application will run the **Semi-Automated process**.

5.2.1 Automated-process

The next figure shows the screens that make up the automated-process. This is shown in Figure 5 in **Block 2** to **Block 5**, if the process finishes with success.

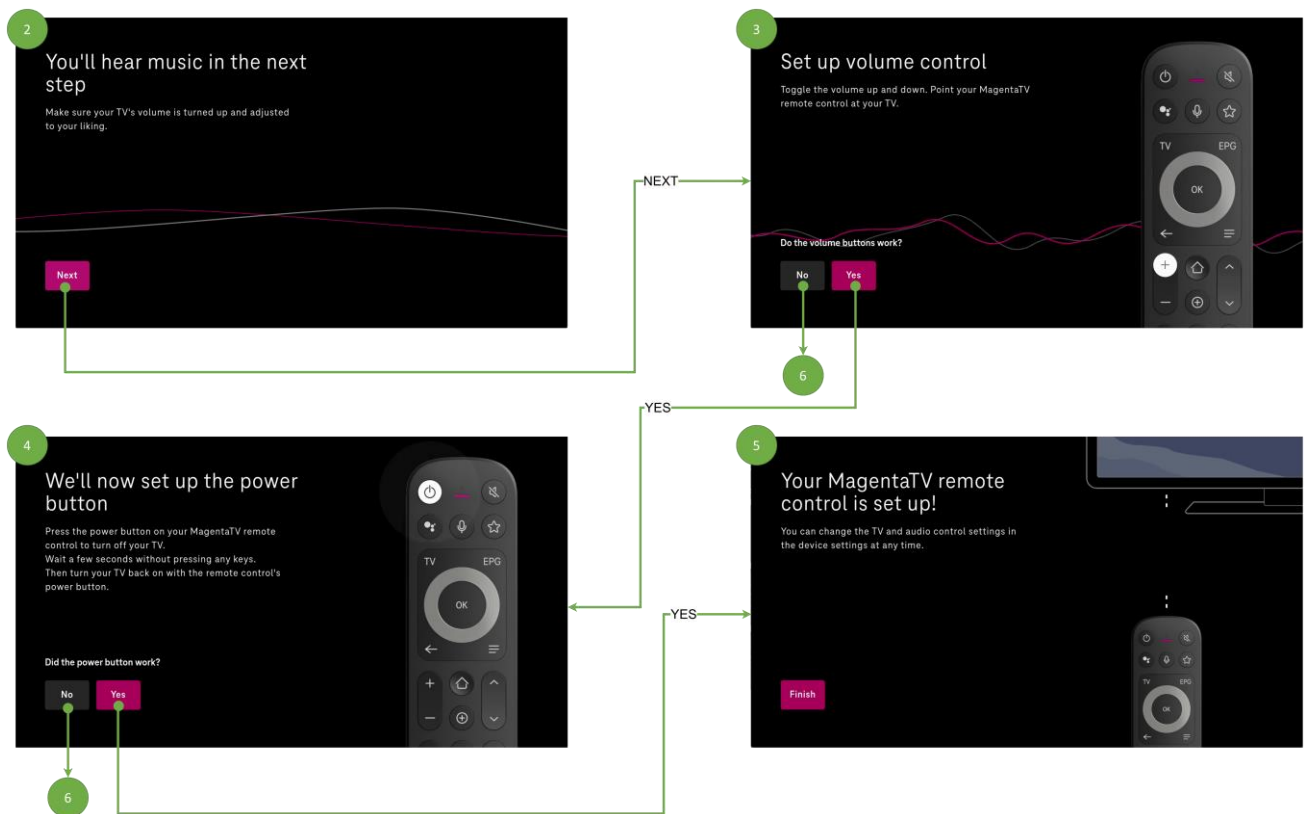


Figure 5. Automated-Process Blocks

In **Block 2**, the RCU Setup Application informs the user that in the next screen music will play and to ensure that the TV volume is turned up. Meanwhile, the RCU Setup Application will search the IRDB Metadata files for the most suitable IR code set.

After this step, the RCU Setup Application will send, via Bluetooth, the Code Set to the RCU so that the RCU can get the IR data from the UDB and decode it into IR waveforms.

Block 3, asks the user to test the IR Code Set sent from the STB. On this screen, the user must only test the volume keys and indicate whether they are working:

- **Yes:** Continues the automatic process.
- **No:** Triggers the **Semi-Automated process (Block 6)**.

Block 4, is like the previous block, but now the power key is tested:

- **Yes:** Continues to **Block 5**.
- **No:** Falls back to the **Semi-Automated process (Block 6)**.

Block 5 is the success block; this means the RCU is programmed with the IR waveforms or code set sent in **Block 2** for all TV keys supported by the RCU.

5.2.2 Semi-Automated Process

In the case where it was not possible to read EDID / pnpID information or the automatic process could not set up the RCU successfully, the RCU Setup Application falls back to the **Semi-Automated** process. In the next figure, it is possible to see the first 3 blocks of the **Semi-Automated process**.

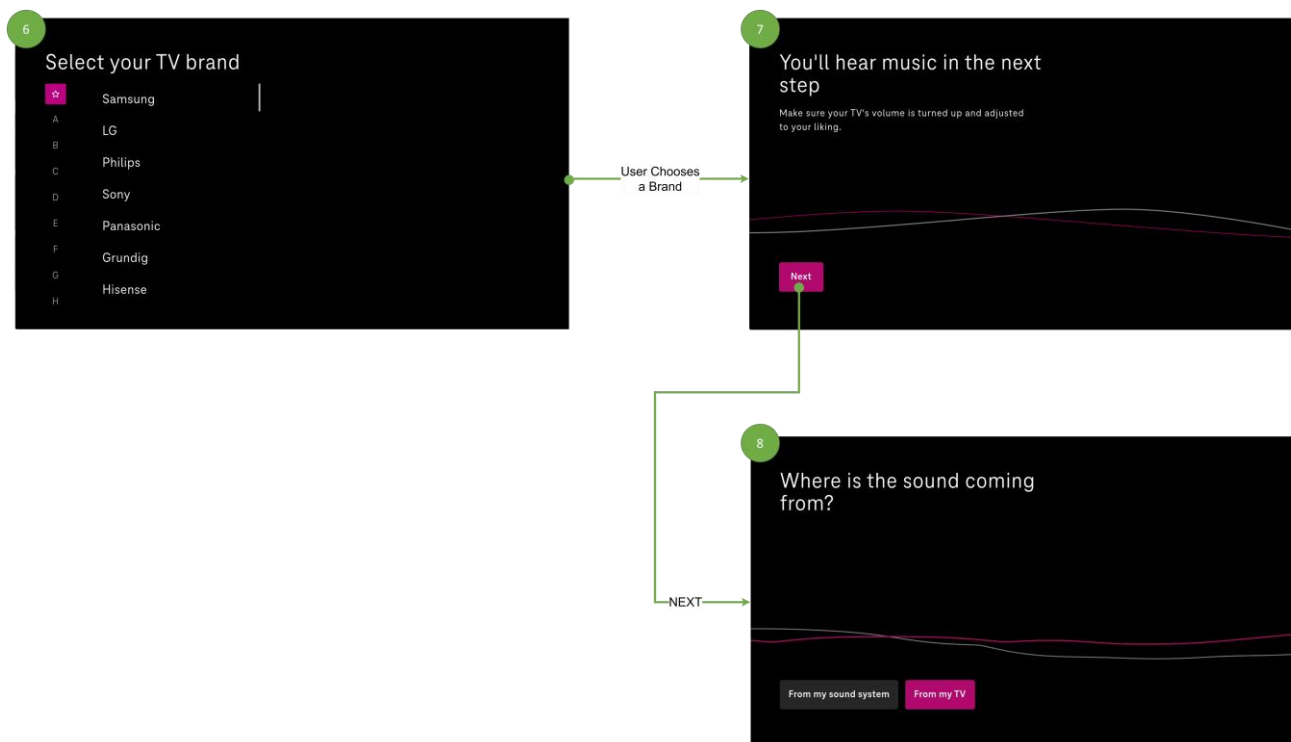


Figure 6. First 3 Blocks of Semi-Automated Process

Block 6, the user selects the TV brand.

Block 7, informs the user that music will play in the next screen and to ensure the TV Volume is turned up.

Block 8, the user indicates where the sound is coming from. This is important because the user could have a sound system coupled to the TV. After this selection, the journey will have two possible paths:

- Semi-Automated Sound System process
- Semi-Automated TV process.

5.2.2.1 Semi-Automated Sound System Process

If the user selects the option that the sound is coming from a sound system, they will encounter the next steps (Figure 7).

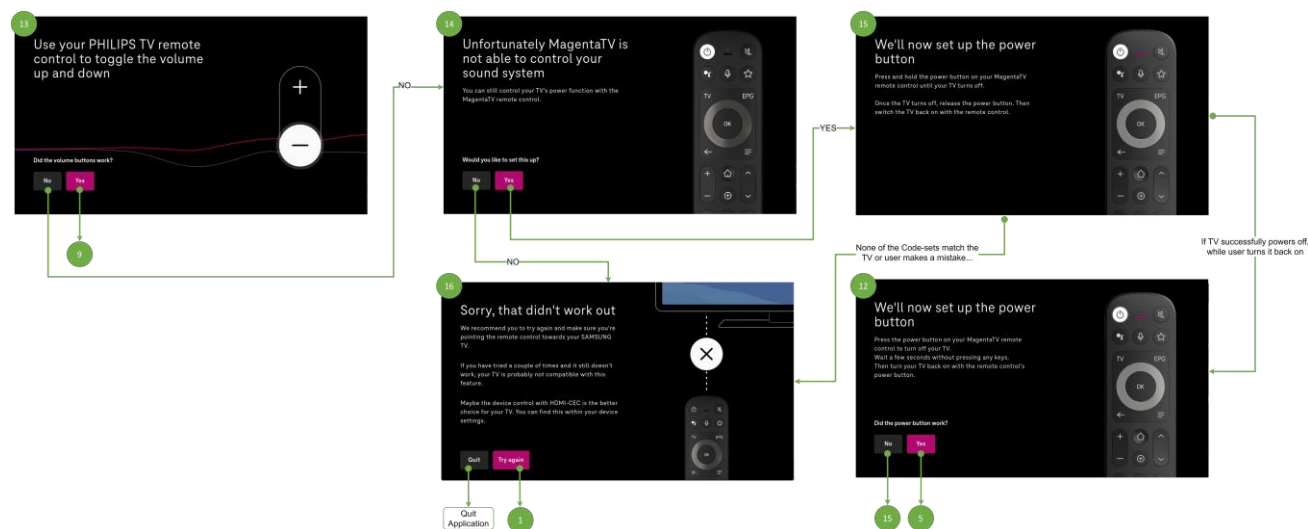


Figure 7. Semi-Automated Sound System Process

Block 13, asks the user if the remote control of the TV (*Philips TV selected in Block 6 by the user for this example*) can control the Volume of the sound system:

- **Yes:** The remote control of the TV can control the Volume of the sound system coupled to the TV, as such the flow continues with the same process as the Semi-Automated TV process (chapter 5.2.2.2).
- **No:** This means that the original RCU for the TV cannot control the Volume of the sound system through HDMI-CEC.

Block 14, offers the user the option to configure the power key with the IR code set to control the TV's power function. If the user refuses, the application will go to the last block (**Block 16**), where the user can opt to try again or quit the application.

On the other hand, if the user accepts to configure the Power key, **Block 15** will appear and prepare the search through the UDB using the power key. This operation works with the user pressing the Power key until the TV turns off. When the TV turns off the user must release the key.

The RCU Setup Application traverses the list of code sets available for the selected brand and sends each code set to the RCU, every 3 seconds, so that the RCU can transmit the Power function.

If the user goes through all the code sets available in the IRDB files, after testing the last code set, the RCU Setup Application jumps to **Block 16**, where the user can opt to try again or quit the application.

However, if the user finds the correct IR waveform to turn off the TV and releases the Power key, the RCU Setup Application will go to **Block 12**, to test the power key. If the power key is not working properly the user goes back to **Block 15** and continues to search for a suitable IR waveform. On the other hand, if the Power key is working correctly, **Block 5** will appear indicating a successful process. Only the RCU's Power key is programmed to control the TV's Power function.

5.2.2.2 Semi-Automated TV process

If the user indicates that the sound is coming from the TV, then the next step in the process is shown in Figure 8; where the user is asked to press the Mute key until the music stops. The RCU Setup Application sends to the RCU, with a periodicity of 3 seconds, each of the Code Sets available in the IRDB metadata files, for the brand which the user selected. When it reaches a Code Set that stops the music, the user must release the Mute key.

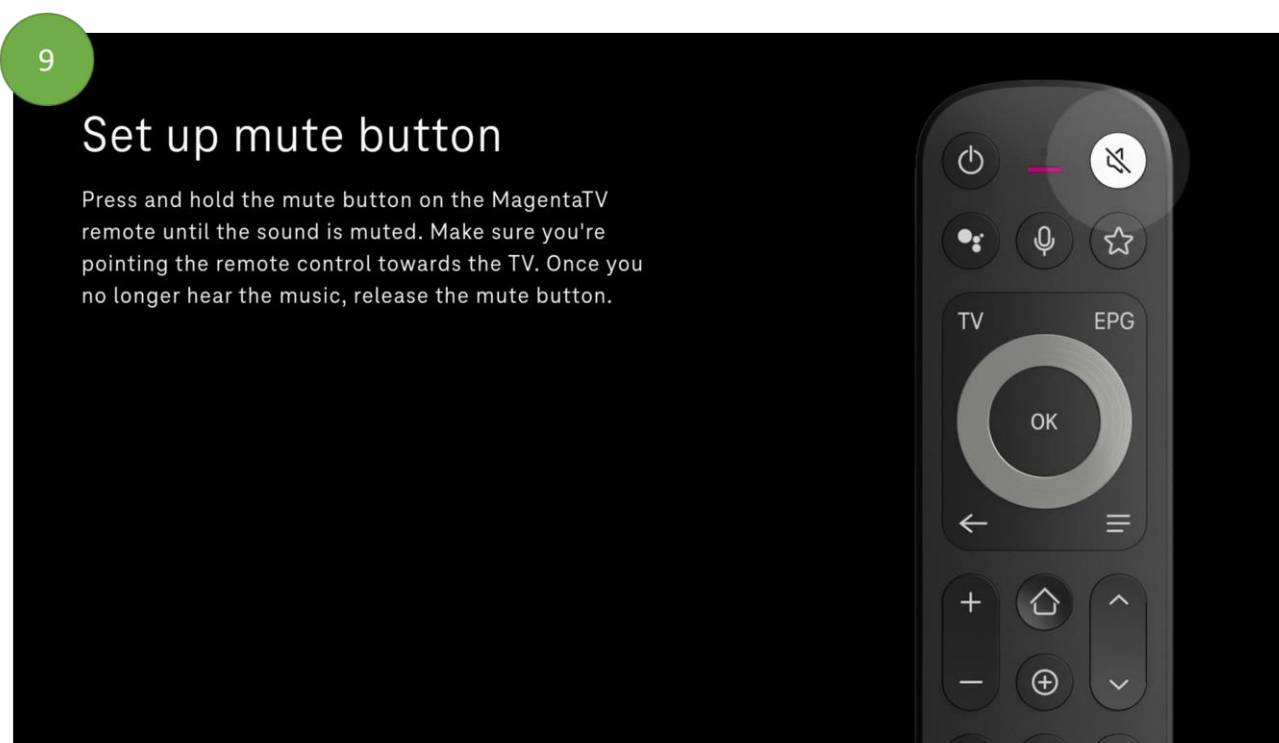


Figure 8. DAS Searching for Code Set using Mute Button

If the search process did not find any Code Set for the user's TV (*in the example a Samsung TV was detected*), in other words, all the Code Sets available in the IRDB metadata files have been tested, it will show the screen in Figure 9. This screen informs the user that the setup was not successful and to opt to try again, starting from the beginning (**Block 1**) or to quit the Application.

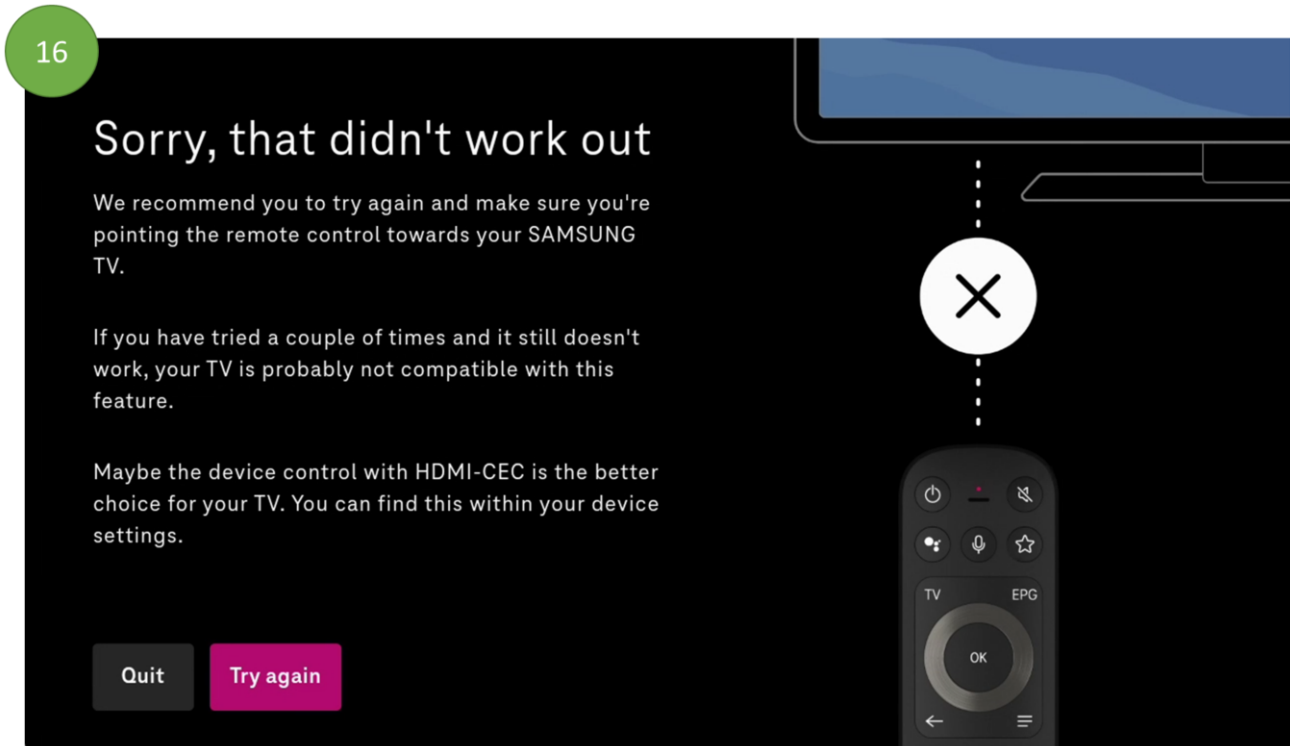


Figure 9. Unsuccessful Setup

The next step is to test all the TV keys available on the RCU after search is successful in **Block 9**. To do this the RCU Setup Application shows the next blocks:

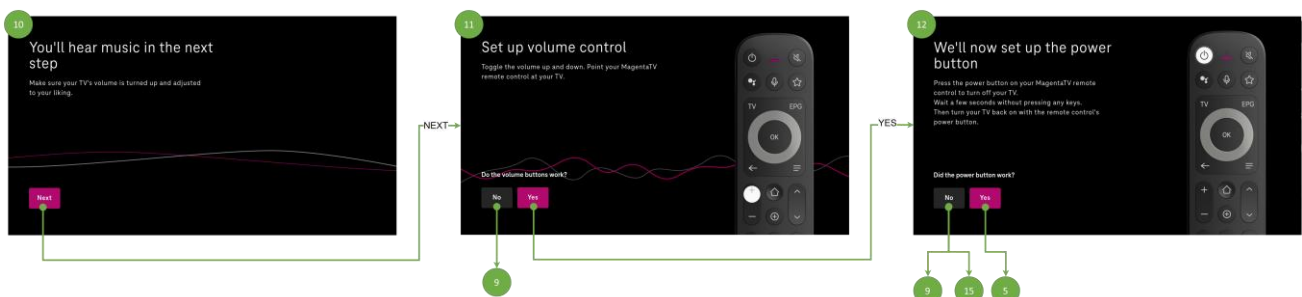


Figure 10. Test keys

In **Block 10**, the user is informed that the next screen will play music and that the TV Volume must be turned up.

Next, in **Block 11**, the user can test the volume keys:

- **Yes:** if it is operational it will pass to **Block 12**.
- **No:** The user returns to **Block 9** where it will continue to search for a suitable code set for his TV.

At the end, in **Block 12**, the user is requested to test the Power key:

- **Yes:** if it is working, it will pass to **Block 5** which means that the setup was a success and programs all the TV keys supported by the RCU.
- **No:** Ther user returns to **Block 9** where it will continue to search for a suitable code set for his TV.

5.2.3 RCU Setup Application's DAS Full Flow

In the next figure, it is possible to check the complete flow that was presented in the previous chapters.

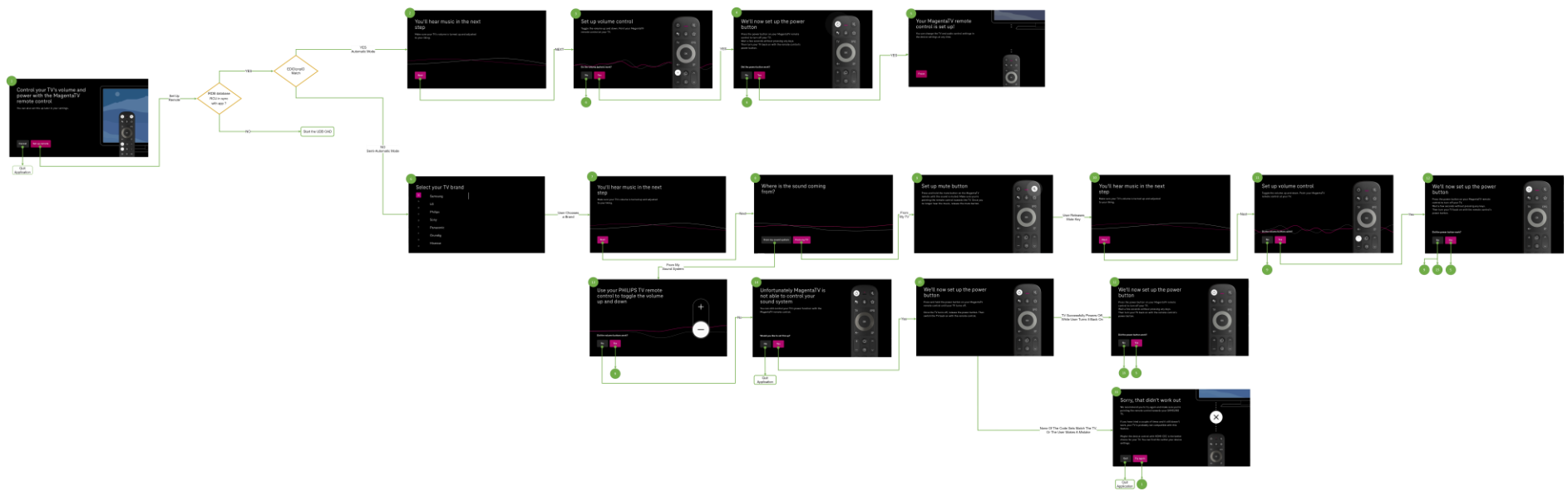


Figure 11. Full Flow RCU Setup DAS Application

5.2.4 DAS Events

There are some events that are triggered by the User or by the Application:

5.2.4.1 Quit the application

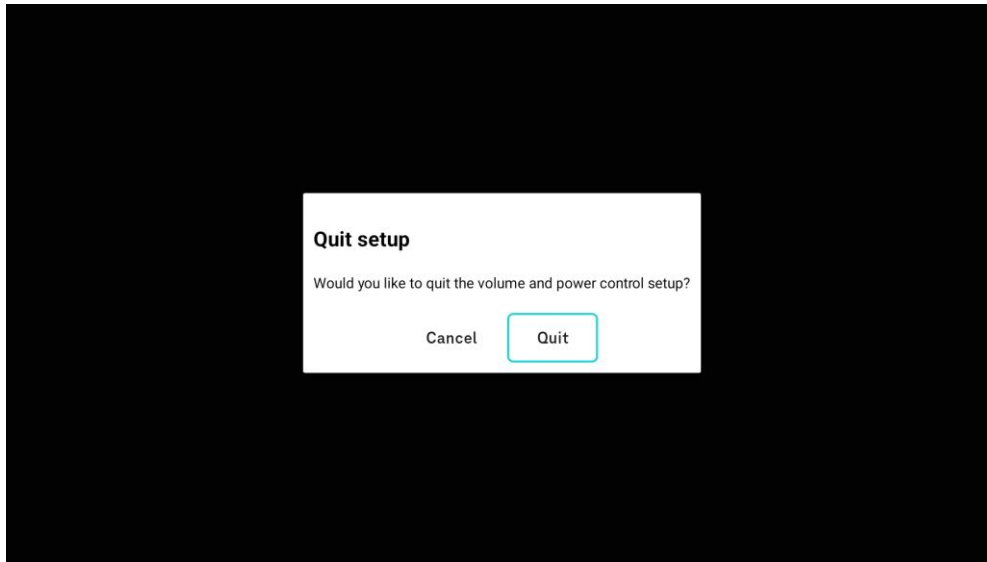


Figure 12. Quit Application

5.2.4.2 RCU disconnection during RCU Setup Application, except on screens 1 and 5.

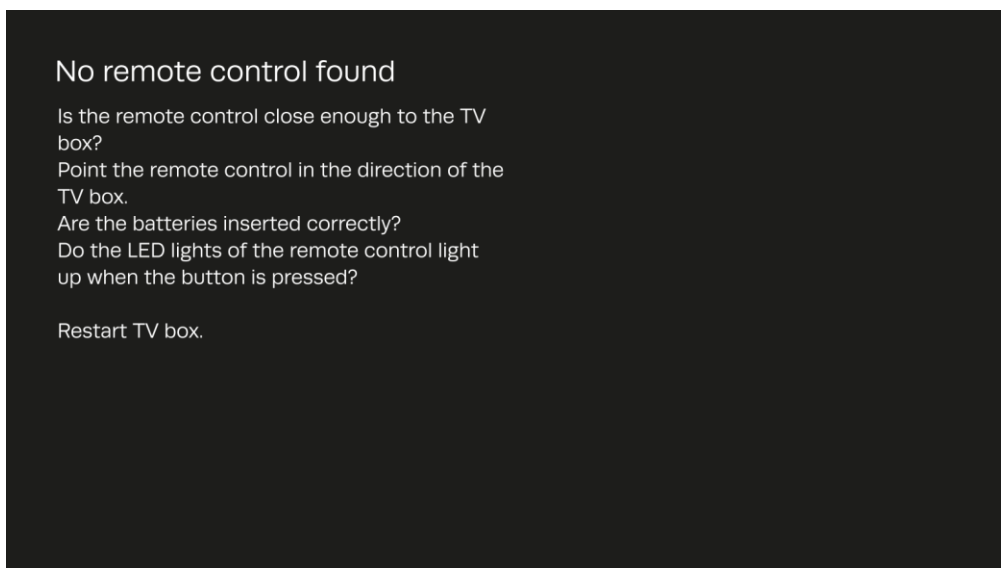


Figure 13. Disconnection during setup

5.2.4.3 DAS time out, when the user does not press a key for 5 minutes in the middle of the DAS process; it will automatically return to **Block 1** to restart the process.

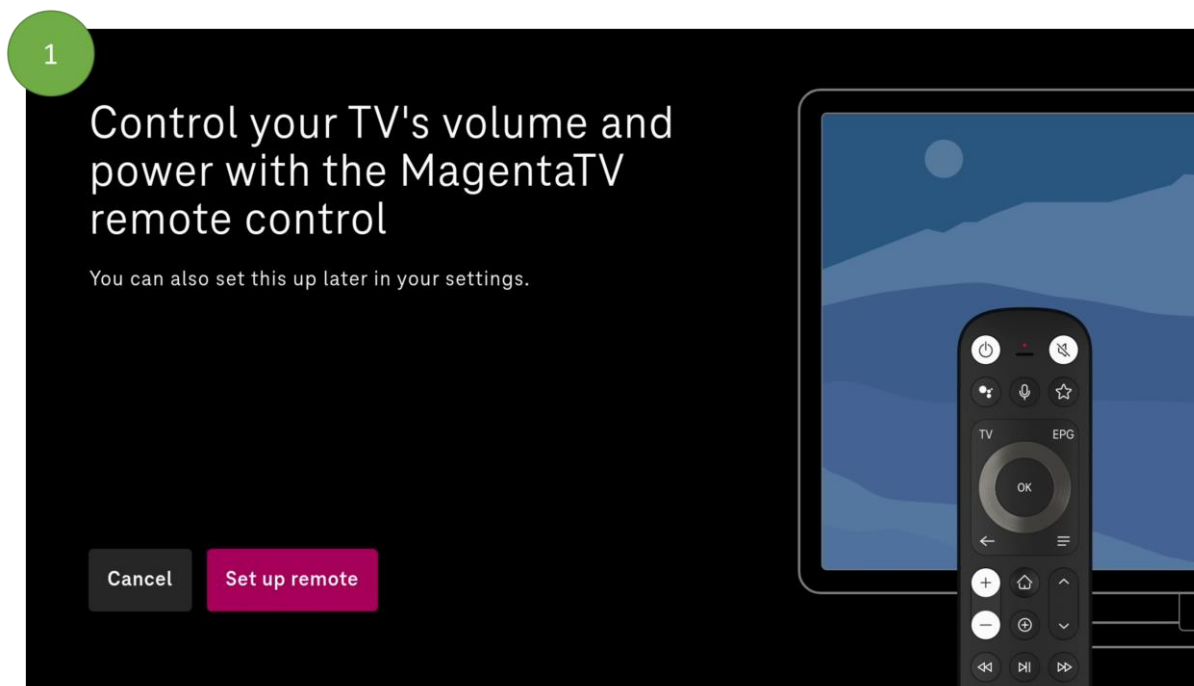


Figure 14. DAS Timeout, Returns to First Block

5.2.5 Das – IRDB Update

The RCU Setup Application upon startup, will check if the IRDB version in the RCU is the same version as the IRDB Metadata files stored in the STB. It will execute a UDB update if these factors occur:

- **The** RCU has no IRDB on the flash of the RCU
- Invalid IRDB on the flash of the RCU
- Newer version of the IRDB on the STB

During this process, the RCU Setup Application will reproduce the next screen:

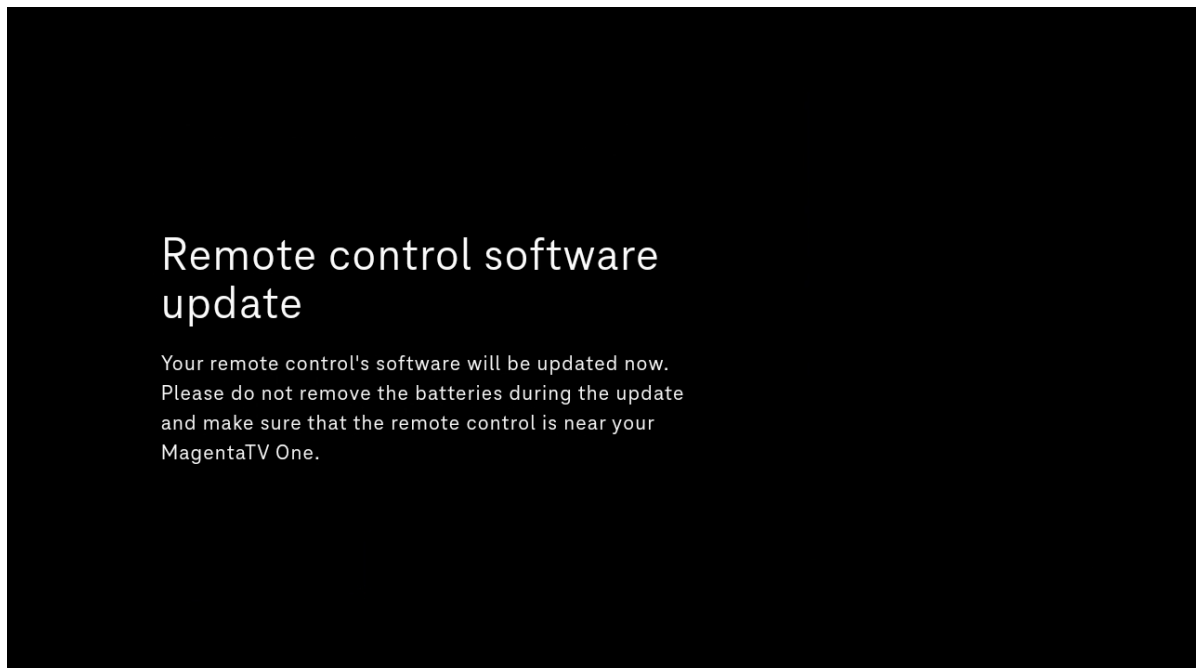


Figure 15. UDB Update Process

If the update of the IRDB is successful, the RCU Application will display the next screen:

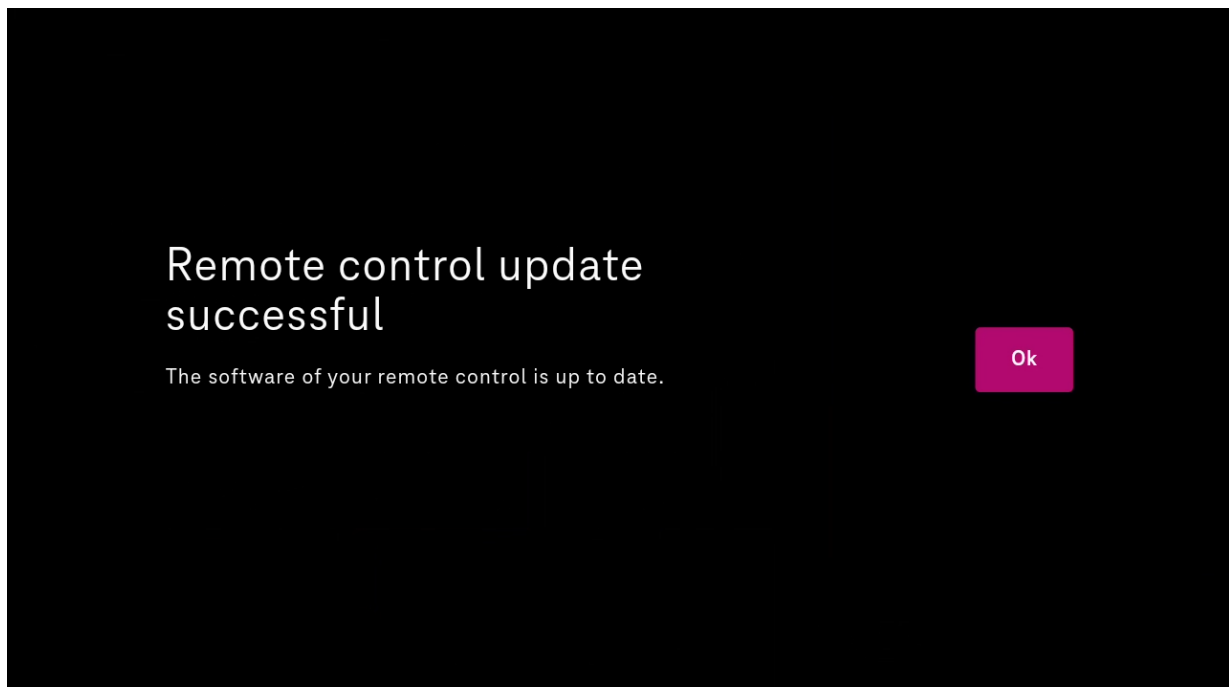


Figure 16. Screen Showing Successful IRDB Update

On the hand, if the IRDB update fails the first time it offers to the user to try it again with the next screen:

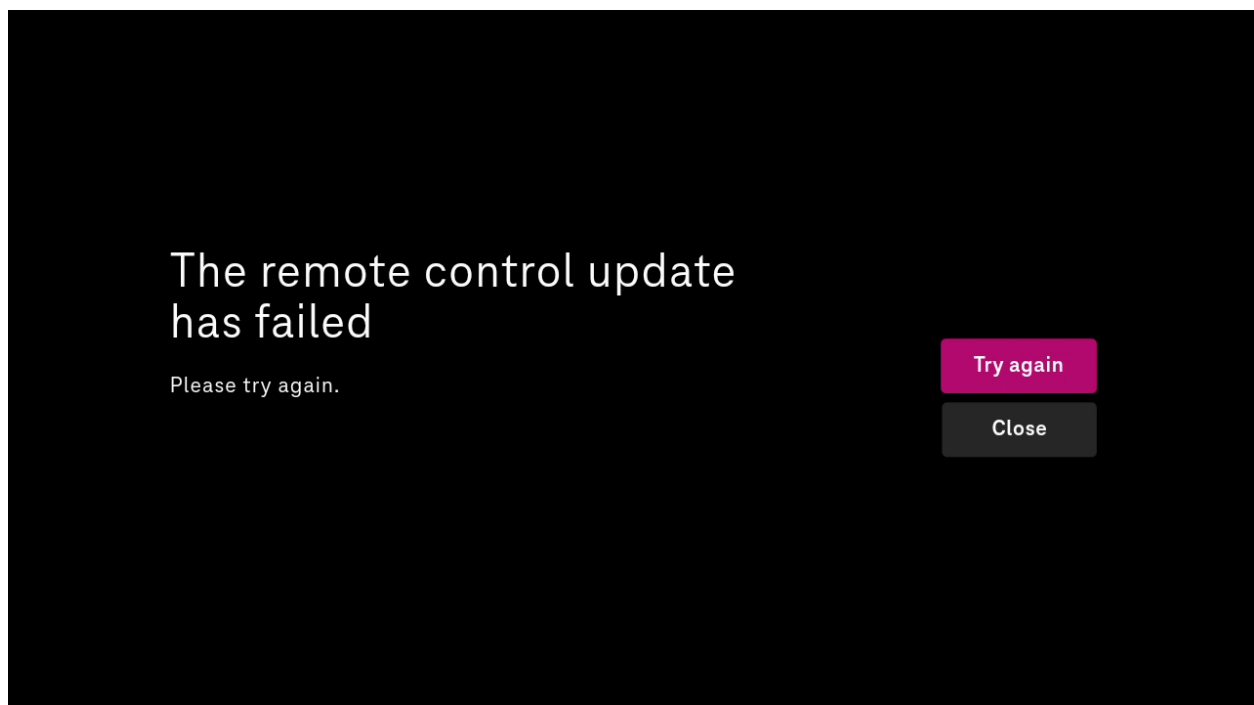


Figure 17. First IRDB Update Fail

If the update error persists, the RCU Setup Application will suggest to reboot the system and try again later, as can be seen in the next image:

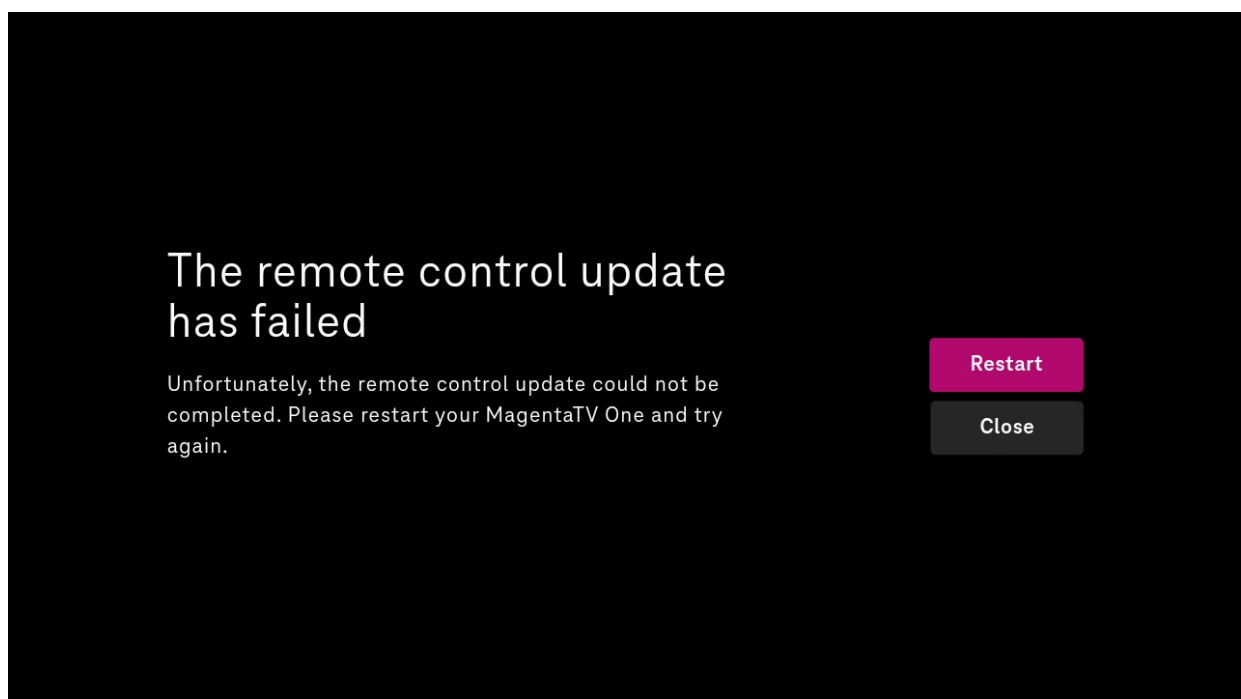


Figure 18. IRDB Update Fails For The Second Time.