Getting started with X-LINUX-GNSS1A1 package for developing GNSS Applications on Linux OS

**Introduction**

The X-LINUX-GNSS1 is a software package for STM32MP1-DK2 Board. The software runs on STM32MP1 and includes user space application, device tree for the Teseo-LIV3F global navigation satellite system (GNSS) device, Library for the NMEA protocol support and POSIX Thread for task scheduling to ensure better asynchronous message parsing.

The software comes with sample implementations of user space applications running on the STM32MP1 board with [X-NUCLEO-GNSS1A1](https://www.st.com/en/ecosystems/x-nucleo-gnss1a1.html) connected to the Arduino Connector on UART and I2C. NMEA library is used to parse the GPS NMEA data that provide several GPS parameters like – latitude, longitude, elevation, speed etc. It contains platform specific Device Tree Modification for STM32MP1 as well.

The source code is designed for portability across a wide range of processing units running Linux .

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Figure 1 X-LINUX Software Architecture Diagram

# 1. X-LINUX-GNSS1 overview

The X-LINUX-GNSS1 software provides user space application running on STM32MP1-DK2 for X-NUCLEO-GNSS1A1 expansion board based on the [Teseo-LIV3F](https://www.st.com/en/positioning/teseo-liv3f.html) tiny Global Navigation Satellite System (GNSS) module. The software package has 3 modules :

1 . gnss\_app (x-linux-gnss)

2. C utility(gnss\_uart and gnss\_i2c)

3. A python utility (gnss\_pynmea2.py)

Each software module can be run independently to fetch the GNSS NMEA data from the X-NUCLEO-GNSS1A1 over UART and I2C.

The device tree for STM32MP1-DK2 board has been modified to configure the UART7 and I2C5 on the Arduino Connector. For UART, underlying dev/ttySTM2 is enabled while for I2C, /dev/i2c-1 is enabled. The X-LINUX-GNSS1 software interacts with the lower layers peripheral drivers ( I2C and UART) using user space application. It uses [termios](https://wiki.st.com/stm32mpu/wiki/TTY_tools) for UART and file descriptor reading for I2C peripheral.

It uses POSIX Thread to run two parallel tasks – Consumer Task and Console Task. Consumer Task fetches the NMEA data, parse it and populates the NMEA data structure. Console Task reads the input from the user and provides the information from the populated NMEA Data structure like position, speed, elevation, wakeup status, etc based on the provided inputs.

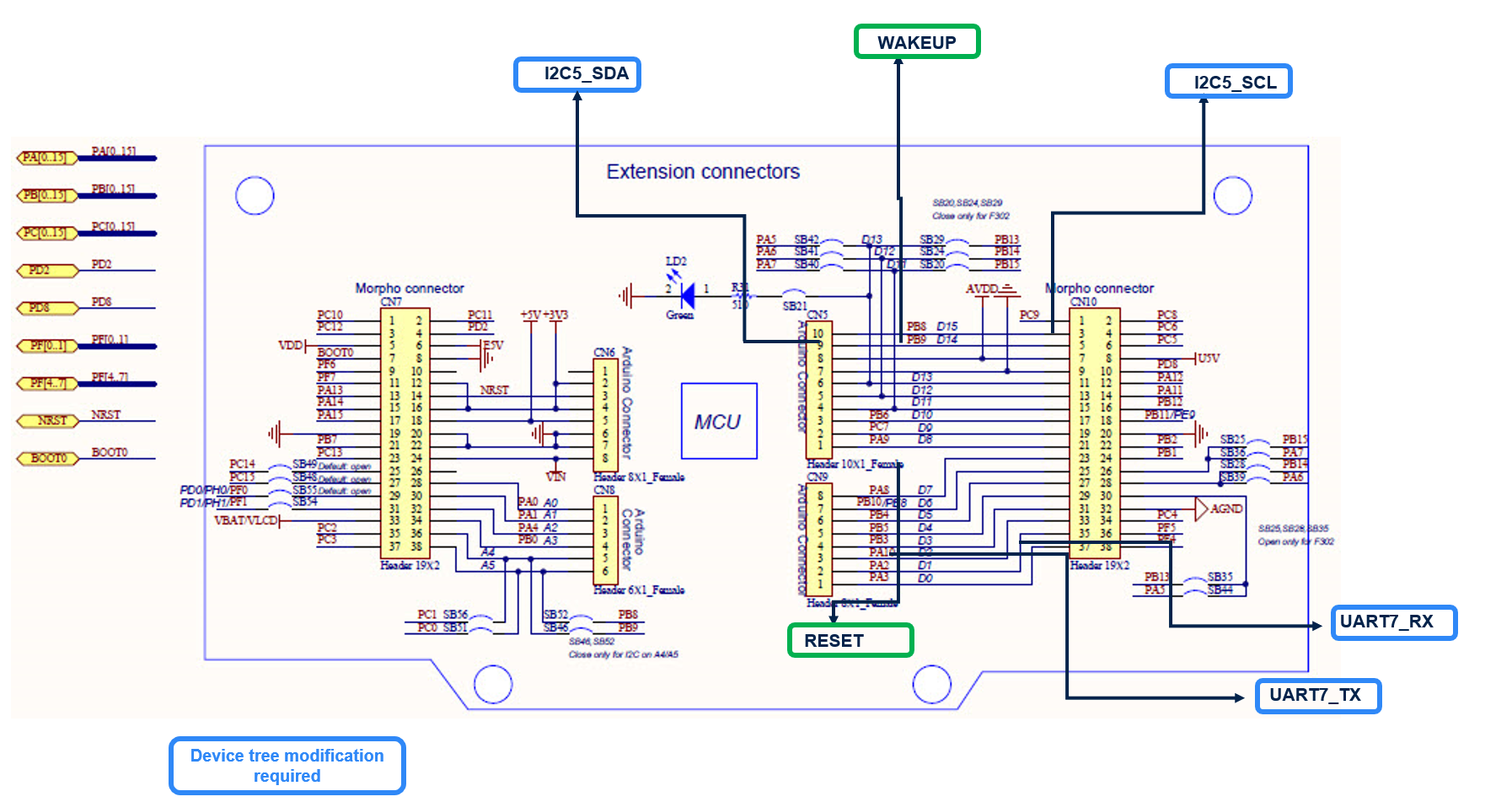


Figure Hardware Connections

## 1.1 Features

Below are the main features of the X-LINUX-GNSS1

* Standalone applications to read the NMEA data over UART and I2C.(gnss\_uart and gnss\_i2c)
* Complete software to build applications using Teseo-LIV3F GNSS device on Linux.
* Middleware for the NMEA protocol
* POSIX Thread task scheduling to ensure better asynchronous message parsing.
* Easy portability across different Linux Platforms
* Sample application example to retrieve and parse GNSS data and send to [ST Asset Tracking Dashboard](https://www.st.com/en/embedded-software/dsh-assetracking.html) for live tracking.(x-linux-gnss)
* Python Example(gnss\_pynmea2.py)
* Free, user-friendly license terms

## 1.2 Architecture

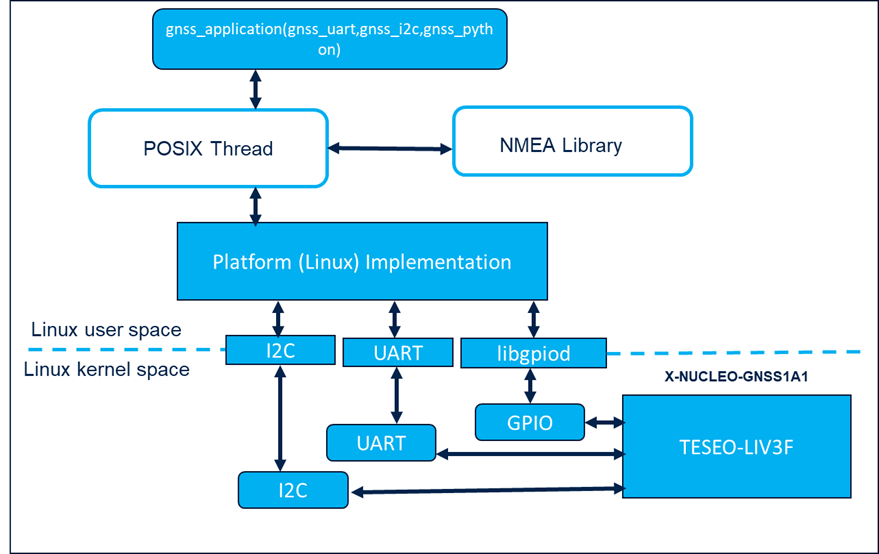


Figure Application Architecture

## 1.3 Software Package Structure

Below is the folder structure of the release package. The release package has Linux user application C example, python example, device tree and Yocto layer recipe. User can run any of the application independently inside the Application folder to retrieve the GNSS NMEA data.



Figure Release Package Structure Top Level

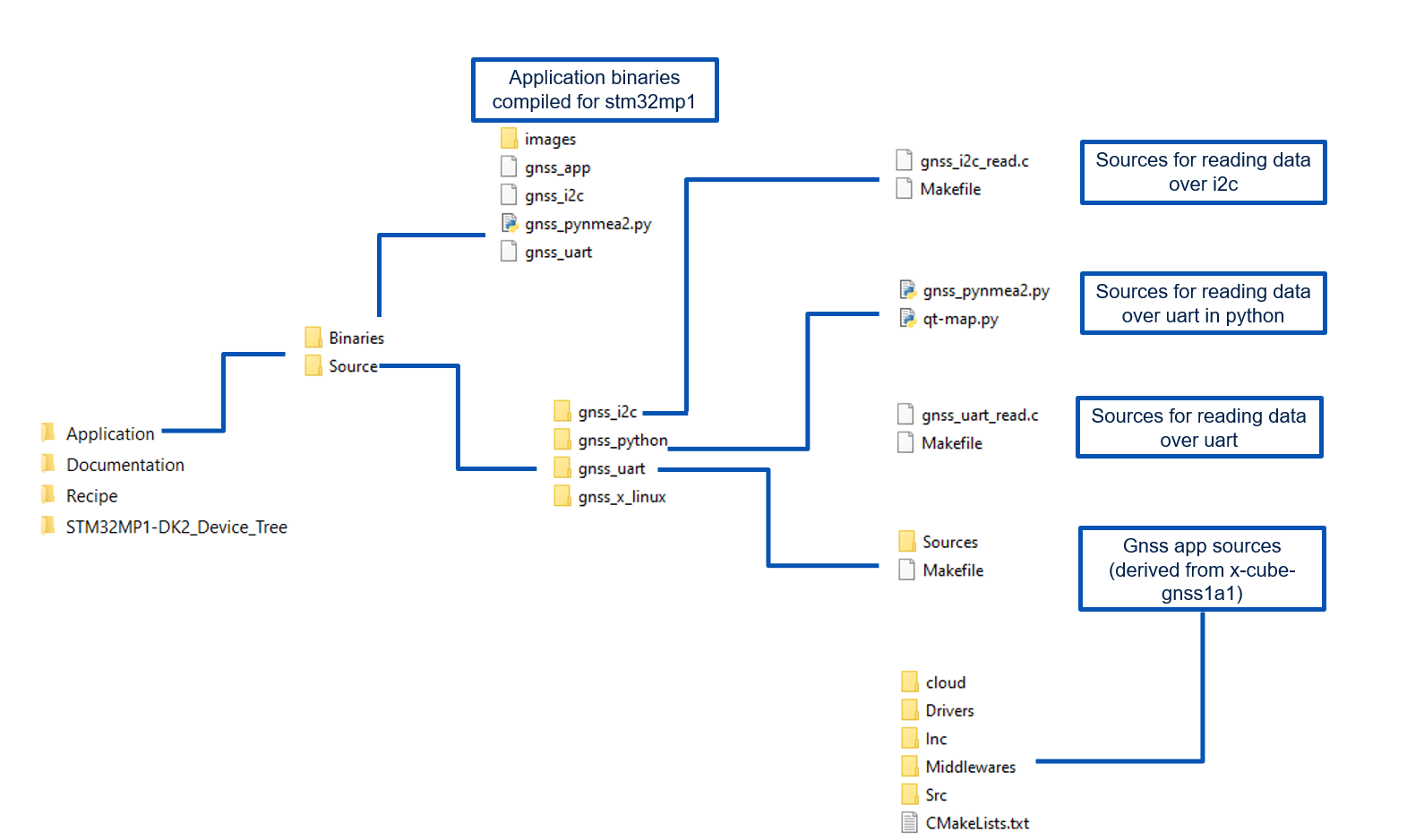


Figure Application Folder Overview

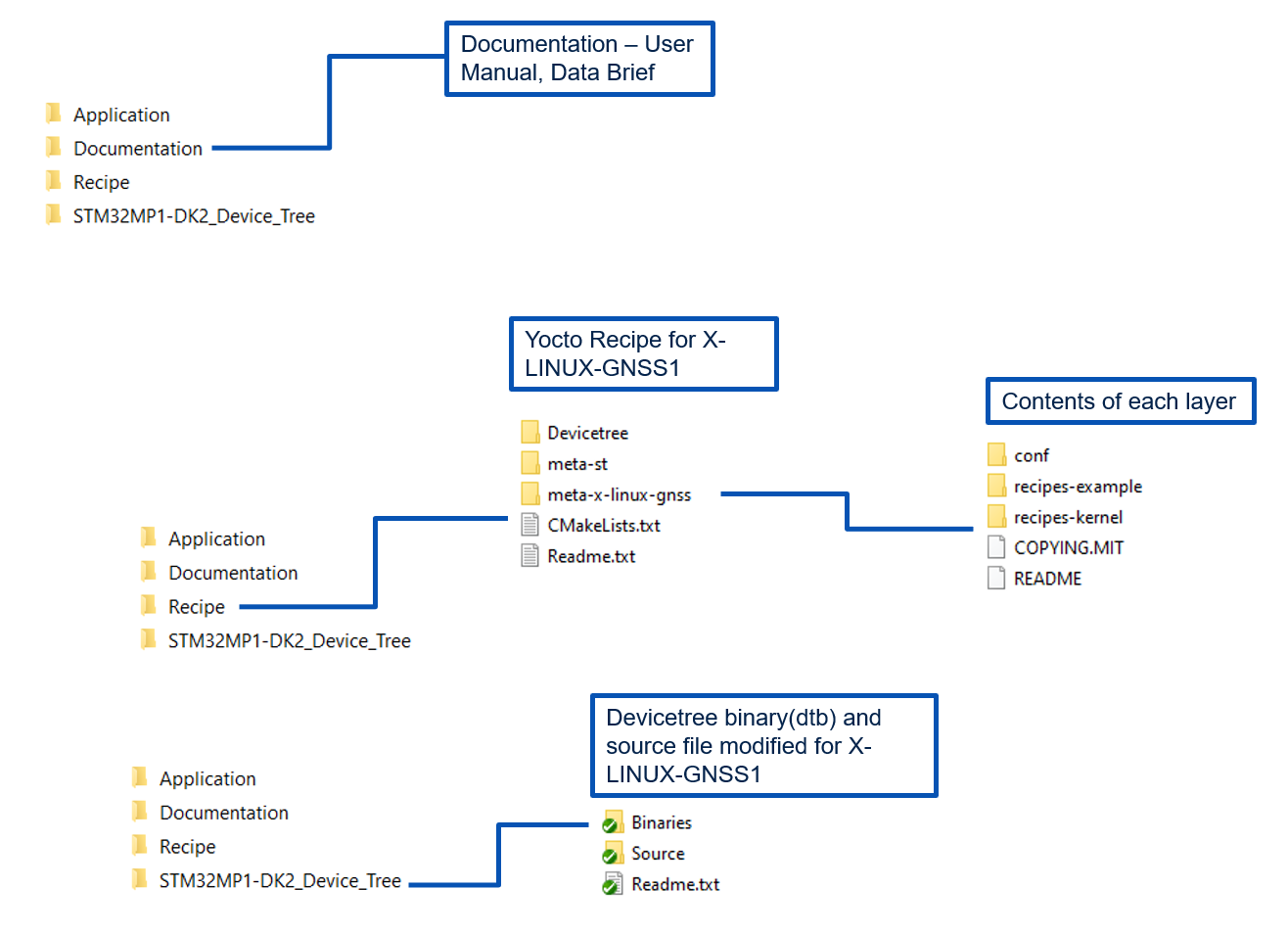


Figure GNSS Other Folder Structures

### 1.3.1 GNSS\_APP

This Application accesses the GPS data over UART (/dev/ttySTM32) and I2C(/dev/i2c-1) interface. The settings for enabling the UART and I2C is provided separately in the device tree file folder.

### 1.3.2 C Utility

This Application is Linux user space C application to read the data from the UART (/dev/ttySTM32) and I2C (/dev/i2c) interface.

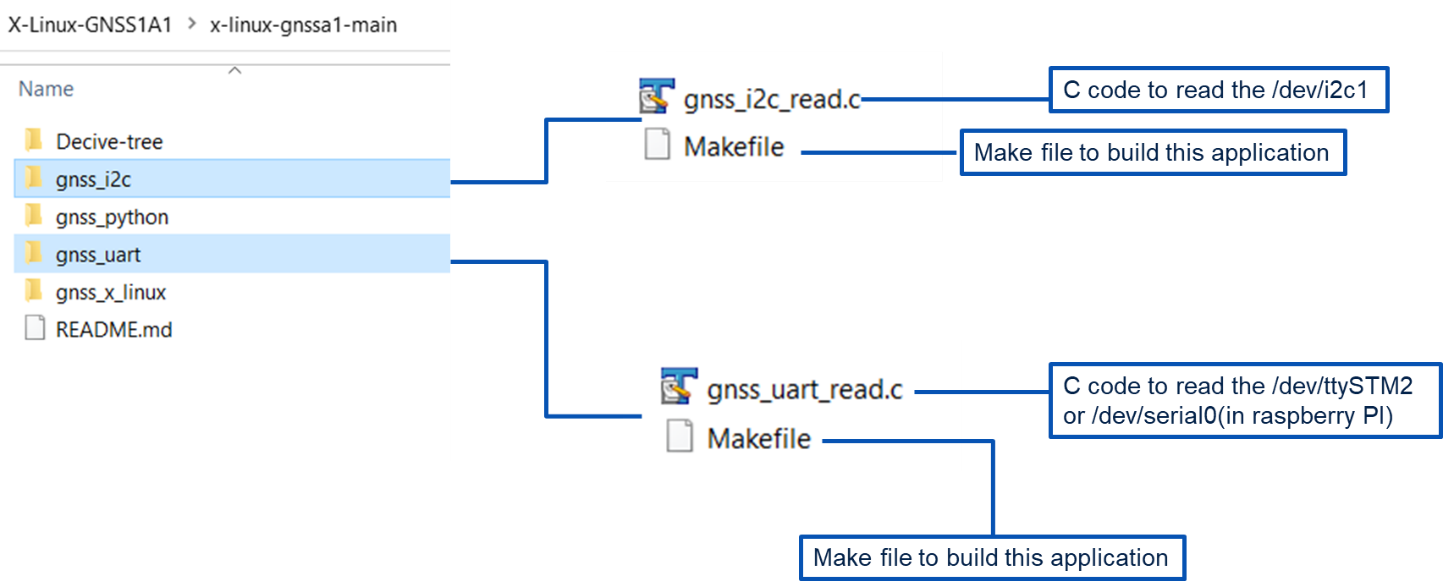


Figure 8 C utility – gnss-uart and gnss-i2c

### 1.3.3 Python Code

This Application is a basic python code to read the data from UART. It uses [pyserial](https://pypi.org/project/pyserial/) and [pynmea2](https://pypi.org/project/pynmea2/) library. You need to have these two dependencies install before using this application.

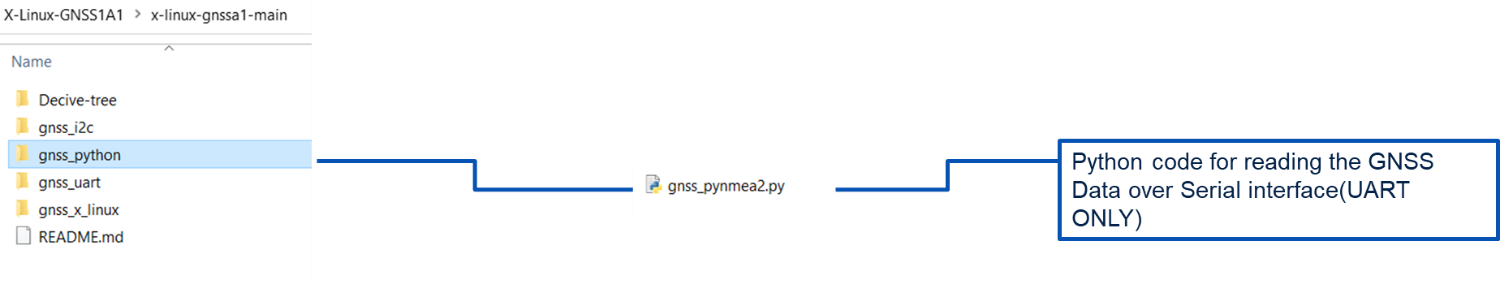


Figure 9 Python Code

# 2.Hardware Setup

The Software is compatible with X-NUCLEO-GNSS1A1 board which can be directly placed on the Arduino connector.

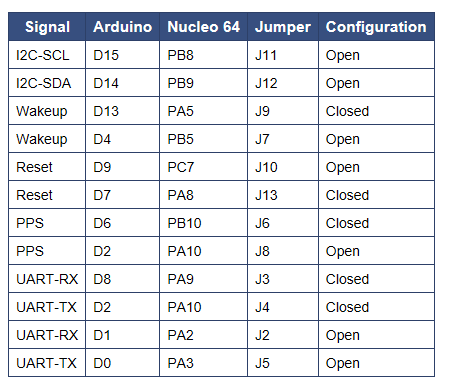
## 2.1 STM32MP1-DK2

Keep the jumper settings as shown below in the figure and place it at the bottom of the STM32MP1-DK2 board.



Figure Hardware Setup – Jumper Settings

Table 1 Jumper Settings



Connect the GPS/GLONASS/Beidou Antenna provided with X-NUCLEO-GNSS1A1. Keep the antenna outdoor for better reception.

# 3. Software Setup

## 3.1 STM32MPU

Below is the software setup which is required for building, flashing, transferring and running the GNSS application.

3.1.1 Installing the SDK

This is required to build the application package. The package already contains the binaries which you can transfer using scp command. In case customization is needed in the Application, installing SDK will help in building it.

Follow this link : <https://wiki.st.com/stm32mpu/wiki/Getting_started/STM32MP1_boards/STM32MP157x-DK2/Develop_on_Arm%C2%AE_Cortex%C2%AE-A7/Install_the_SDK>

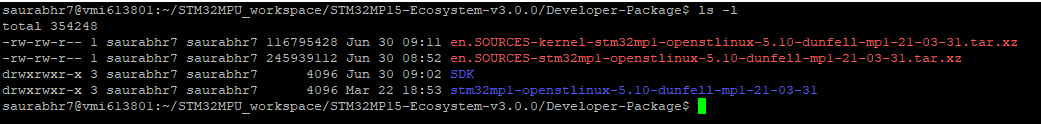
3.1.2 Downloading the kernel Sources (Developer Package)

This is required to build the device tree. The package already contains the binaries(dtb) which can be transferred using scp command.

Follow this link:

<https://wiki.st.com/stm32mpu/wiki/Getting_started/STM32MP1_boards/STM32MP157x-DK2/Develop_on_Arm%C2%AE_Cortex%C2%AE-A7/Modify,_rebuild_and_reload_the_Linux%C2%AE_kernel>

Once Downloaded it has the following contents :



#KERNEL SOURCE PATH = ~/STM32MPU\_workspace/STM32MP15-Ecosystem-v3.0.0/Developer-Package/stm32mp1-openstlinux-5.10-dunfell-mp1-21-03-31/sources/arm-ostl-linux-gnueabi/linux-stm32mp-5.10.10-r0/linux-5.10.10$

3.1.3 Downloading the Distribution Package

This is required to build the recipes and creating stm32mp1 images which has GNSS application and device tree settings embedded.

Follow this link:

<https://wiki.st.com/stm32mpu/wiki/STM32MP1_Distribution_Package>

once downloaded it will have these two directories

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3.1.4 Connecting to the Board via Hotspot

This is required to transfer the built binaries (application, device trees). Alternatively, you can try 3.1.5 method as well to transfer data over WIFI

Follow this link:

<https://wiki.st.com/stm32mpu/wiki/How_to_configure_a_wlan_interface_on_hotspot_mode>

3.1.5 Connecting to the Board via Wi-Fi

This is required to transfer the built binaries (application, device trees)

Follow this link:

<https://wiki.st.com/stm32mpu/wiki/How_to_setup_wifi_connection>

# 4.Building and Running the example

This section explains the way to build and run the package. The code can be built using simple Makefile utility for Starter Package or using bitbake for Distribution package. For python, no building/compiling is required but it is dependent on pyserial and pynmea2 package which needs to be installed.

Below conventions are used below:

|  |  |
| --- | --- |
| #Descriptive comments | Comment describing steps |
| $command | Development or Host PC/machine command prompt. Text after $ is command |
| $command | Stm32mpu command prompt. Text after $ is command |
| STM32MP1 | STM32MP1-DK2 Board ( both C and F Series) |

## 4.1 Using Make file (For Starter Package)

Download the X-LINUX-GNSS1 package as a first step. Make a directory gnss

$mkdir gnss

$cd gnss

#You will be prompted for username and password for GitHub, enter it

$git clone https://github.com/rawatsaurabh/X-LINUX-GNSS1.git

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X-LINUX-GNSS1\_V1.0.0 package will be downloaded inside X-LINUX-GNSS1 folder

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Figure Cloning the Package

### 4.1.1 GNSS\_APP

For running the gnss\_app below steps is to be followed

1. Modify the device tree or copy it from the folder provided (see below)
2. Build the device tree and transfer it to STM32MP1-DK2
3. Build the gnss\_app
4. Transfer the gnss\_app executable to STM32MP1 over Wi-Fi or hotspot to STM32MP1-DK2 board

# Modify the device tree or copy it from the folder provided (see below)

#Copy the dts file in the directory: X-LINUX-GNSS1/X-LINUX-GNSS1\_V1.0.0/ STM32MP1-DK2\_Device\_Tree/Source to the kernel source directory at <KERNEL SOURCE PATH>/ arch/arm/boot/dts/

Download the Kernel Sources as described in section 3.1.2.

$cd /path-to/X-LINUX-GNSS1/X-LINUX-GNSS1\_V1.0.0/Application/Source/gnss\_x\_linux/Sources

$cp stm32mp157c-dk2.dts <KERNEL SOURCE PATH>/ arch/arm/boot/dts

#Source the path of the SDK . You have already downloaded and Installed the SDK in steps above. – 3.1.1 .Source <SDK PATH>/SDK/environment-setup-cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi

$ source ~/STM32MPU\_workspace/STM32MP15-Ecosystem-v3.0.0/Developer-Package/SDK/environment-setup-cortexa7t2hf-neon-vfpv4-ostl-linux-gnueabi

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#Build the device tree

$cd <KERNEL SOURCE PATH>

$make ARCH=arm CROSS\_COMPILE=arm-linux-gnueabihf- menuconfig

$make arch=ARM menuconfig

$make ARCH=arm uImage vmlinux dtbs LOADADDR=0xC2000040 (Optional)

$make ARCH=arm modules (Optional)

#Once the dtbs are built copy them to the STM32MP1-DK2 board.Make sure to connect to it using hotspot mode or over WIFI.

$scp <KERNEL SOURCE PATH>/arch/arm/boot/dts/stm32mp157c\_dk2.dtb [root@192.168.72.1:/boot](mailto:root@192.168.72.1:/boot)

#Build the gnss\_app

$cd gnss

#build the gnss\_app . cd to the gnss\_x\_linux location and do make

$cd <path to>\X-LINUX-GNSS1\X-LINUX-GNSS1\_V1.0.0\Application\Source\gnss\_x\_linux

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Figure 14 STM32MPU - Build Application

The executable (gnss\_app) will be formed in the same location where Makefile is present

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#Transfer the application to STM32MP1

scp gnss\_app [root@192.168.72.1:/](mailto:root@192.168.72.1:/)

#On STM32MP1 board sync and reboot

$sync

$reboot

#Running the Application

$cd /

$./gnss\_app

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Figure 18 STM32MPU - Run Application

Text

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Figure gnss\_app Selecting the options - Select 11 to get the GPS Co-ordinates

### 4.1.2 C Utility

The steps are same as gnss\_app

Enter the <Path to > /X-LINUX-GNSS1\_V1.0.0\Application\Source\gnss\_uart and do make.

gnss\_uart will be created in the same directory where Makefile is present. Transfer it to STM32MP1-DK2 using scp .

$cd /

$./gnss\_app

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Figure running gnss\_uart

$./ gnss\_i2c

Text

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Figure running gnss\_i2c

### 4.1.3 Python Code

Installing the dependencies on STM32MPU

You need to install the [pyserial](https://pypi.org/project/pyserial/#files) and [pynmea2](https://pypi.org/project/pynmea2/#files) for this.

#Installing pyserial

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Figure 25 STM32MPU Installing Python Dependencies - Pyserial

$wget <https://files.pythonhosted.org/packages/1e/7d/ae3f0a63f41e4d2f6cb66a5b57197850f919f59e558159a4dd3a818f5082/pyserial-3.5.tar.gz>

$tar xvf pyserial-3.5.tar.gz

$cd pyserial-3.5

$python setup.py install or python3 setup.py install

#installing pynmea2

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Figure 25 STM32MPU Installing Python Dependencies – Pynmea2

$wget https://files.pythonhosted.org/packages/88/b9/a0fed4563f5c73eb8f4d7bb115a455863c5327ae824ac1772e2a4b1b95ee/pynmea2-1.18.0.tar.gz

$tar xvf pynmea2-1.18.0.tar.gz

$cd pynmea2-1.18.0

$python setup.py install or python3 setup.py install

#Enter the python folder, copy the readmap.py file to stm32mp1

$Python3 readmap.py

#Running the python code

Text

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Figure 27 STM32MPU Run Snapshot

### 4.1.4 Maps and Asset Tracking

X-LINUX-GNSS1provides an example to send GNSS data to the cloud over http. ST Asset Tracking Dashboard is used to display the live GNSS data . Below are the steps to getting started with sending GNSS data to cloud

#Create a login at ST Asset Tracking Dashboard: <https://dsh-assetracking.st.com/> , its free

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Figure ST Asset Tracking Dashboard

Login or create an account at <https://dsh-assetracking.st.com/#/login>

Graphical user interface, application

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Figure ST Asset Tracking Login

Once logged in , create a device (device name and device id) from the Devices Tab

Graphical user interface

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Figure ST Asset Tracking Dashboard Home

Graphical user interface, application, Teams

Description automatically generated

Figure ST Asset Tracking Dashobard Creating a device ID and Device Name

#Create API Key which will be used to send data to this Asse Tracking Dashboard

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Figure ST Asset Tracking Generating new API Key

Location of endpoint:

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Figure ST Asset Tracking - Note down the endpoint

#Modify the data in the creds.conf file as per the endpoint, device Id and the API Key

$cd /path-to/X-LINUX-GNSS1\_V1.0.0/Application/Source/gnss\_x\_linux/Sources/cloud

$vi creds.conf

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Description automatically generated

#modify creds.conf file device\_id,api\_key and endpoint

http\_endpoint = https://jim3rgi6d3.execute-api.eu-central-1.amazonaws.com/v1/telemetry

api\_key = 8d54837c-5793-4adb-ad4c-efa11e5bfee1.c0e77783-3dd8-40a6-b4e0-2fead68eb033

device\_id = 201303Graphical user interface, text

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#build the Application (in case only creds file is modified, this step is not required)

The steps are same as for building and deploying the gnss\_app

Enter option “20” to upload the data to cloud. Make sure your STM32MP1-DK2 board is connected to internet

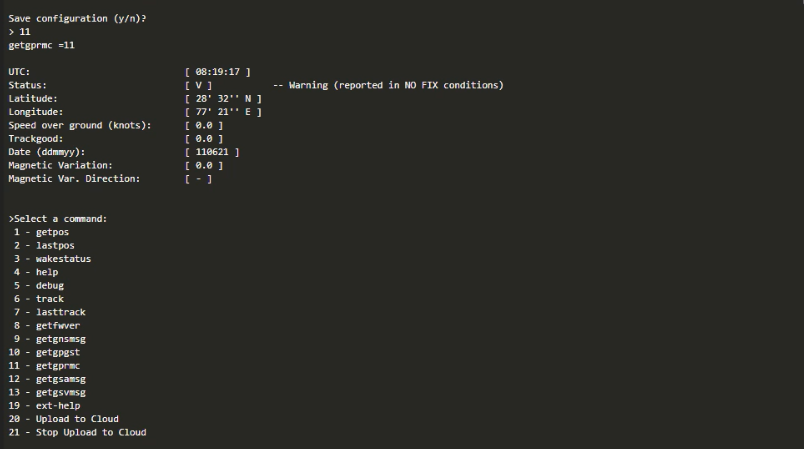


Figure Running gnss app and enabling cloud upload option (“20”)

And then you will get the below logs and the live tracking on the Asset Tracking Dashboard.

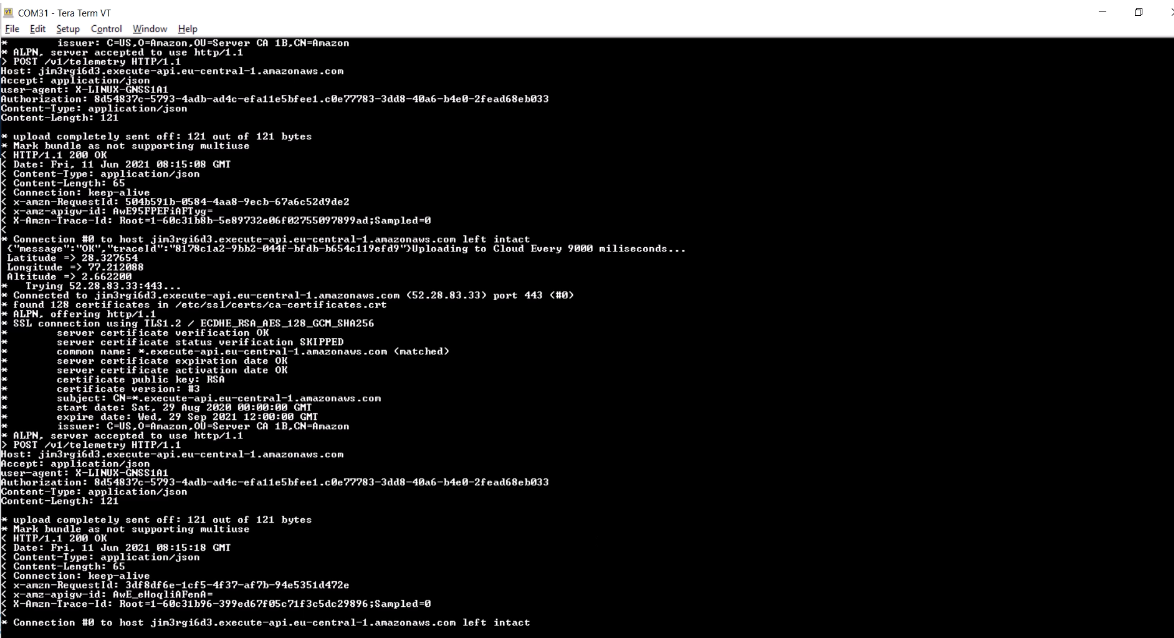


Figure Gnss app sending data to ST Asset Tracking Dashboard over HTTP

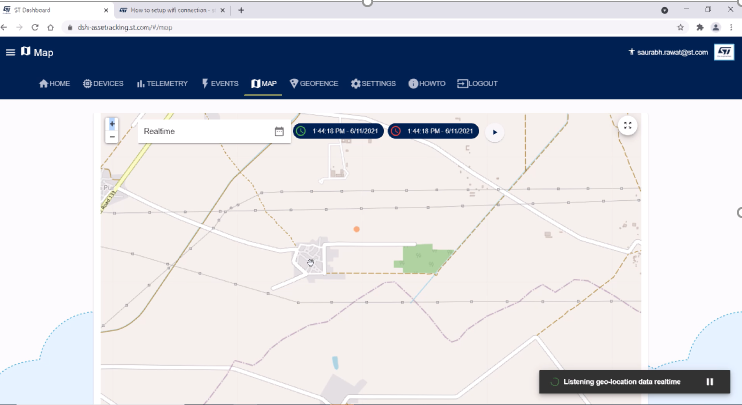


Figure Gnss app live data

## 4.2 Using BitBake (For Distribution Package)

### 4.2.1 GNSS\_APP

Download the distribution package as shown in Section 3.1.3: <https://wiki.st.com/stm32mpu/wiki/STM32MP1_Distribution_Package>

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$DISTRO=openstlinux-weston MACHINE=stm32mp1 source layers/meta-st/scripts/envsetup.sh

Text

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$ bitbake st-image-weston

#You will be in build directory after executing above command

#Download the GNSS code inside the build(build-openstlinuxweston-stm32mp1) directory

build-openstlinuxweston-stm32mp1$ git clone https://github.com/rawatsaurabh/X-LINUX-GNSS1.git

A screenshot of a computer

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#Once cloned you will see the X-LINUX-GNSS package inside the build directory

$ls

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See existing layers,X-LINUX-GNSS will not be present unless you do add layer.

$bitbake-layers show-layers

Text

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#Create meta-x-linux-gnssa1 layer inside ../layers/meta-st folder: <https://wiki.st.com/stm32mpu/wiki/How_to_create_a_new_open_embedded_layer>

$bitbake-layers create-layer --priority 7 ../layers/meta-st/meta-x-linux-gnss1

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$cd ../layers/meta-st

#See the structure of the layers

$tree meta-x-linux-gnss1

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#Come back to build directory

$cd <path-to-build-directory>/build-openstlinuxweston-stm32mp1

#Add a layer

$ bitbake-layers add-layer ../layers/meta-st/meta-x-linux-gnss1

#Run bitbake-layer show layers to see the newly formed layer

$ bitbake-layers show-layers

Graphical user interface, text

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#Modify the ../layers/meta-st/meta-x-linux-gnss1 folder to include the recipe contents

#Copy the contents from the layer provided in the x-linux-gnssa1 package to the newly created layer ../layers/meta-st/meta-x-linux-gnss1

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#1. Add recipe name(here it is “example”) inside layers/meta-st/meta-st-openstlinux/conf/layer.conf

For this add below line in file layers/meta-st/meta-st-openstlinux/conf/layer.cof

IMAGE\_INSTALL\_append += "example"

$vi ../layers/meta-st/meta-st-openstlinux/conf/layer.conf

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Text

Description automatically generated

\*for simplicity we have kept the name of the recipe as “example”

#2. recipes-example modification

$ cd /home/saurabhr7/dp/layers/meta-st/meta-x-linux-gnss1

ls -l

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$ cd recipes-example/example

Text

Description automatically generated

#Modify example\_0.1.bb

Delete its content and copy the content from the example\_0.1.bb provided

Text

Description automatically generated

#Copy example\_0.1.bbappend inside recipes-example/example

$ cp build-openstlinuxweston-stm32mp1/x-linux-gnssa1/X-LINUX-GNSS1\_V1.0.0/Recipe/meta-x-linux-gnss/recipes-example/example/example\_0.1.bbappend layers/meta-st/meta-x-linux-gnss1/recipes-example/example/.

#3.recipes-kernel

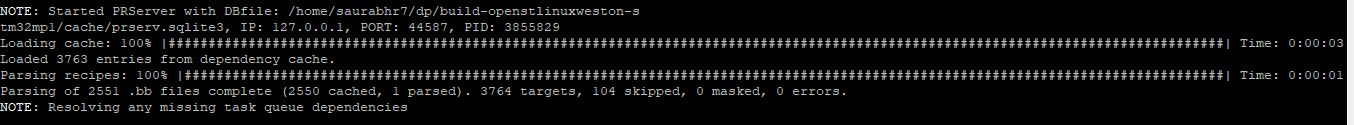
Copy the recipes-kernel to the layer folder as below:

$ cp -rf build-openstlinuxweston-stm32mp1/x-linux-gnssa1/X-LINUX-GNSS1\_V1.0.0/Recipe/meta-x-linux-gnss/recipes-kernel/ layers/meta-st/meta-x-linux-gnss1/

#4.BitBake st image Weston

bitbake st-image-weston





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#4.New Images will be formed in the tmp-glibc/deploy/images/stm32mp1/ directory

$cd tmp-glibc/deploy/images/stm32mp1/

#FlashLayout\_sdcard\_stm32mp157c-dk2-trusted.tsv and FlashLayout\_sdcard\_stm32mp157f-dk2-trusted will be created besides other images

Follow below link to flash the binary.

<https://wiki.st.com/stm32mpu/wiki/STM32MP15_Discovery_kits_-_Starter_Package#Image_flashing>

#Once board is rebooted with the new Binary follow the below commands to run the application

$cd /

$./gnss\_app

## 4.3 Another method to add the x-linux-gnss layer

#Download the Distribution Package and do bitbake.Doing bitbake for the best time will show the EULA accept prompt, Accept it ( type “y” and press enter)

$DISTRO=openstlinux-weston MACHINE=stm32mp1 source layers/meta-st/scripts/envsetup.sh

$bitbake st\_image\_weston

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#You will be inside the build directory.once bitbake is done , download the gnss package inside the build directory.

$ git clone <https://github.com/rawatsaurabh/X-LINUX-GNSS1.git> Text

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#Create a layer : meta-x-linux-gnss

$bitbake-layers create-layer --priority 7 ../layers/meta-st/meta-x-linux-gnss

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Description automatically generated with medium confidence

#Add a layer a layer : meta-x-linux-gnss

$ bitbake-layers add-layer ../layers/meta-st/meta-x-linux-gnss

A screenshot of a computer

Description automatically generated with medium confidence

#See the added layer layer : meta-x-linux-gnss

$bitbake-layers show-layers

Graphical user interface, text

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#Add the IMAGE\_INSTALL\_append line as shown below in the layer.conf at the end

$vi ../layers/meta-st/meta-st-openstlinux/conf/layer.conf

IMAGE\_INSTALL\_append += "example"

Text

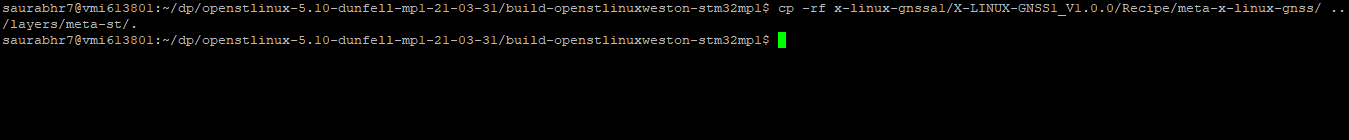
Description automatically generated

#Delete Completely meta-x-linux-gnss

$ rm -rf ../layers/meta-st/meta-x-linux-gnss/

#And copy the layer provided from the x-linux-package

$ cp -rf x-linux-gnssa1/X-LINUX-GNSS1\_V1.0.0/Recipe/meta-x-linux-gnss/ /path-to-/layers/meta-st/.

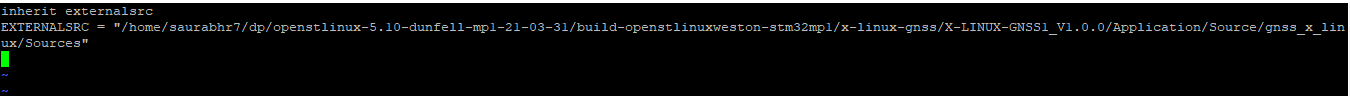


#Add the Sources path(Location where CMakeLists.txt is present) inside example\_0.1.bbappend as shown below.

# “/path-to/openstlinux-5.10-dunfell-mp1-21-03-31/build-openstlinuxweston-stm32mp1/x-linux-gnss/X-LINUX-GNSS1\_V1.0.0/Application/Source/gnss\_x\_linux/Sources”

Inside layers/meta-st/meta-x-linux-gnss/recipes-example/example/example\_0.1.bbappend

$vi ../layers/meta-st/meta-x-linux-gnss/recipes-example/example/example\_0.1.bbappend



#Build the st image

$ bitbake st-image-weston

#New Images will be formed in the tmp-glibc/deploy/images/stm32mp1/ directory

$cd tmp-glibc/deploy/images/stm32mp1/

#FlashLayout\_sdcard\_stm32mp157c-dk2-trusted.tsv and FlashLayout\_sdcard\_stm32mp157f-dk2-trusted will be created besides other images

Follow below link to flash the binary.

<https://wiki.st.com/stm32mpu/wiki/STM32MP15_Discovery_kits_-_Starter_Package#Image_flashing>

#check if below file is present on discovery kit

$ ls -l /dev/ttySTM2

#Run the application

$ /usr/bin/gnss\_app or directly /gnss\_app

# 5.0 Revision History

Table 2 Revision History

|  |  |  |
| --- | --- | --- |
| Date | Version | Changes |
| 6th June 2021 | 1.0 | Initial Release |

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