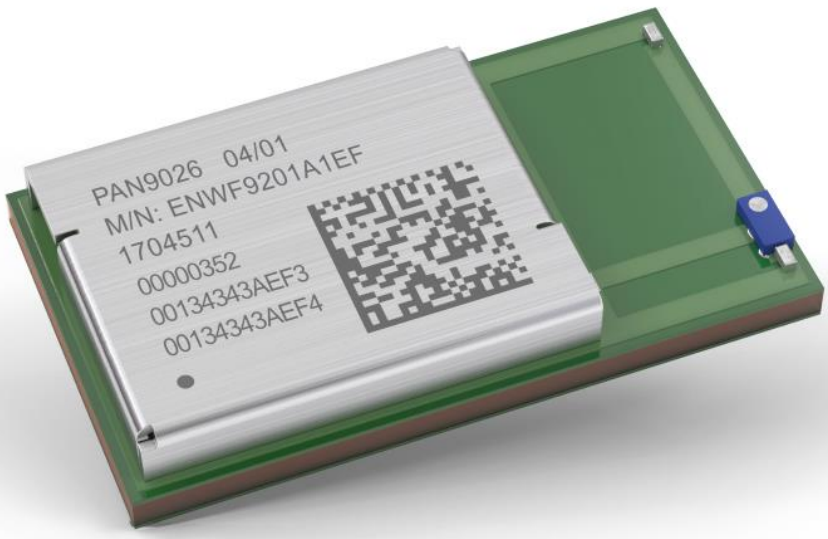
Panasonic

PAN9026

Wi-Fi Dual Band 2.4/5 GHz and Bluetooth Module

Developer's Guide

Rev. 1.0



Wireless Modules

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Table of Contents

1 About This Document

1.1 Purpose and Audience

This Developer's Guide explains how to re-create "developer image" which is based on Yocto Project Linux.

The image is suited for the PAN9026-IMX system, which consists of a Wandboard Dual (WB-IMX6U-BW) and the PAN9026-MSD.

This Developer's Guide also describes the necessary steps to work with the resulting system and explains some background details of the implementation.

The document is intended for experienced software engineers that want to get the PAN9026 module to work in their custom Linux-based host system.

1.2 Revision History

Revision	Date	Modifications/Remarks
1.0	2018-09-13	Initial version

1.3 Use of Symbols

Symbol	Description
	**Note** Indicates important information for the proper use of the product. Non-observance can lead to errors.
	**Attention** Indicates important notes that, if not observed, can put the product's functionality at risk.
	**Tip** Indicates useful information designed to facilitate working with the module.
⇨ [chapter number] [chapter title]	**Cross reference** Indicates cross references within the document. **Example:** Description of the symbols used in this document ⇨ 1.3 Use of Symbols.
✓	**Requirement** Indicates a requirement that must be met before the corresponding tasks can be completed.
➔	**Result** Indicates the result of a task or the result of a series of tasks.
This font	**GUI text** Indicates fixed terms and text of the graphical user interface. **Example:** Click **Save**.

Symbol	Description
Menu > **Menu item**	**Path** Indicates a path, e.g. to access a dialog. **Example:** In the menu, select **File** > **Setup page**.
`This font`	**File names, messages, user input** Indicates file names or messages and information displayed on the screen or to be selected or entered by the user. **Examples:** `pan1760.c` contains the actual module initialization. The message `Failed to save your data` is displayed. Enter the value `Product 123`.
[Key]	**Key** Indicates a key on the keyboard, e.g. **[F10]**.

1.4 Related Documents

[1] PAN9026 Quick Start Guide

Please refer to the Panasonic website for more information as well as related documents
⇨ 7.2 Product Information.

2 Overview

The PAN9026-IMX is a development platform for the Wi-Fi/BT PAN9026 module.

The PAN9026 module requires a fairly powerful host processor that executes both the low-level Wi-Fi driver as well as some high-level Wi-Fi application software.

Because of this, the Wandboard was chosen as the hardware platform. It is based on the well-known and powerful NXP i.MX6 processor and provides a separate µSD card slot for attaching peripheral devices like the PAN9026-MSD.

A Linux-based installation was chosen as the software platform. The Linux kernel provides an established environment for running a Wi-Fi driver and the available Wi-Fi applications make it possible to use the PAN9026 module to its full extend.

Two different software environments are available for the PAN9026-IMX.

First, an Ubuntu Linux-based environment is available to showcase all the different possibilities of the PAN9026 module, which also allows the user to experiment with the system using a graphical user interface. This environment is described in the PAN9026 Quick Start Guide which is available separately.

Second, a Yocto Project Linux-based environment is available to showcase the easy integration into a customer-specific build environment. This environment is described in this Developer's Guide.

This Developer's Guide assumes deep knowledge about how to use the Yocto Project to create a Linux-based system image. It will not go into details and answer questions that are considered out of scope for PAN9026-IMX.

The Linux environment created by using the Yocto Project provides access to the Wi-Fi and Bluetooth features of the PAN9026 module.

Please refer to the Panasonic website for related documents ⇨ 7.2 Product Information.

2.1 Wi-Fi Features

The Linux environment created by using the Yocto Project provides access to the Wi-Fi features of the PAN9026 module by supplying a web server running on a Wi-Fi access point.

After a connection to that access point has been established, it is possible to interact with the PAN9026 module with the browser.

It can simultaneously connect to another Wi-Fi access point and relay any internet connectivity from there.

2.2 Bluetooth Features

The Linux environment created by using the Yocto Project also provides access to the Bluetooth features of the PAN9026 module by providing several Bluetooth applications.

All Bluetooth applications have been implemented using "Blue SDK" from OpenSynergy.

For further information please refer to http://www.opensynergy.com/en/products/blue-sdk.

It is possible to select one of the following Bluetooth applications through the user interface provided by the web server.

The Bluetooth Basic Rate A2DP application allows the PAN9026-IMX to become a Bluetooth audio sink. It is possible to playback audio from a remote device that is connected via Bluetooth Basic Rate, which is then output via the audio jack.

Alternatively the PAN9026-IMX may become a Bluetooth Low Energy proximity beacon using the “AltBeacon” Protocol, which is a popular beacon implementation used for indoor navigation.

3 Installation

The PAN9026-IMX consists of the following components:

- PAN9026-MSD – µSD card form factor
- Wandboard Dual (WB-IMX6U-BW)
- USB Power cable as power supply

The following additional components are not included, but are required for all use cases:

✓ µSD card with at least 2 GB capacity
✓ RS232 serial connection cable (interface the built-in UART port to a control PC)
✓ Some Wi-Fi capable device like a mobile phone or a tablet

Finally the following additional components are not included, but may be required depending on the use case:

✓ Headphones with 3.5 mm jack (in order to listen to Bluetooth audio)

3.1 Boot Card Setup

The Wandboard actually consists of two separate parts:

- The Baseboard that contains all the connectors and
- A system-on-module that contains the i.MX6 processor.

The system-on-module is located on the back of the Wandboard and may have a heat-spreader covering the processor.

The Wandboard has two µSD card slots:

- One for the boot medium, which is located on the system-on-module, and
- One for peripheral devices, which is located on the Baseboard.

Usually the µSD card with the Ubuntu Linux image is already inserted in the µSD card slot on the system-on-module so that the Wandboard will boot from it.

Notice that the µSD card slot of the system-on-module can be found on the left side when the Wandboard is turned around and the audio connectors are facing downwards:

In order to replace the µSD card gently press the connector and the µSD card will spring out.

Remember the orientation of the contacts – the contacts must face upwards when the µSD card is inserted.

3.2 Device for Remote Control

Certain functions of the PAN9026-IMX can be remote controlled via Wi-Fi, so a Wi-Fi capable device for controlling is needed.

For the sake of simplicity it is assumed that an Android mobile phone is used for this purpose, but other devices may be used as well.

4 Developer Image

The Yocto Project is used to create a custom embedded Linux distribution for the PAN9026-IMX.

For further information please refer to https://www.yoctoproject.org.

A fairly powerful Linux-based machine running a compatible Linux distribution is necessary to build the developer image.

Ubuntu Linux 16.04 LTS has been successfully used to build the developer image.

Ubuntu Linux 18.04 LTS has been used successfully as well, but the Yocto Linux environment will emit a warning message.

The build process may take several hours to complete and requires an internet connection.

Make sure that all prerequisites as explained on https://www.yoctoproject.org/docs/2.4.3/yocto-project-qs/yocto-project-qs.html in the chapter “The Build Host Packages” are installed on the system.

The “repo” tool is used to manage the necessary Git repositories.

For further information please refer to https://gerrit.googlesource.com/git-repo.

Make sure that the “repo” tool is installed on the system. It may be necessary to customize the user name and e-mail address as well.

After creation, this distribution consists of a disk image which includes a recent Linux kernel, kernel modules for both the Wi-Fi and Bluetooth parts of the PAN9026 module, a complete wireless access point setup (including IPv4 forwarding) and a running web server to remote control the setup.

The disk image containing this custom embedded Linux distribution is called “developer image” for the rest of this document.

4.1 Prerequisites

The following items are additionally needed to successfully execute the instructions that follow:

- ✓ Panasonic “pan-yocto” software package ZIP file
- ✓ Marvell software package ZIP file

4.1.1 Panasonic Software Package

The Panasonic “pan-yocto” software package ZIP file contains the environment and the necessary “recipe” files for the Yocto Project Linux to create the “developer image”.

Please contact your local Panasonic sales representative in order to get access to the latest version of the “pan-yocto” software package ZIP file.

4.1.2 Marvell Software Package

A recent software package from Marvell is necessary to build the drivers for the PAN9026 module.

The following Marvell software package has been used as a basis for the developer image:

`SD-WLAN-SD-BT-8977-U16-MMC-V16.68.1.p170-16.26.1.p170-C4X16544_V2-MGPL.zip`

To download this or the latest version, please refer to https://extranet.marvell.com.

Please contact your local Panasonic sales representative in order to get access to the Marvell Extranet.

4.2 Configuration Steps

1. Unpack the Panasonic “pan-yocto” software package ZIP file on the build machine.

   The file contains the following minimal Git repositories:

   - `manifest`
   - `meta-pideu`
   - `pideu-base`

The repo manifest file `manifest/default.xml` is the starting point for starting the image creation.

2. Execute the following shell commands in the location where the ZIP file was unpacked:

```
repo init -u manifest
repo sync
```

➔ The “repo” tool will download all necessary external dependencies for the build that are not included in the delivery.

3. After the download has finished, unzip the `Marvell driver` to the right location.

   In this example it is assumed that the download of the driver was done to the folder `/tmp/`.

```
unzip /tmp/SD-WLAN-SD-BT-8977-U16-MMC-V16.68.1.p170-16.26.1.p170-C4X16544_V2-MGPL.zip -d ./sources/meta-pideu/recipes-kernel/kernel-modules/
```

4.3 Build Steps

The following requirements must be met:

✓ Successfully configuration

1. Setup the environment in the directory `build`:

```
TEMPLATECONF=$(pwd)/sources/base/conf MACHINE=pan-imx DISTRO=pan source setup-environment "build"
```

The directory `conf` within the folder `build` is only updated the first time when the folder `build` is populated.

Consecutive executions of the above command will not synchronize the content of the folder `conf`.

2. Start the actual build from the directory `build`.

```
bitbake image-pideu
```

➔ The resulting binary image is named `imx-uboot-spl-<timestamp>-mmcblk.direct`.

4.4 µSD Card Creation Steps

The binary image that was created in the previous step can now be written to a µSD card, for example by using the built-in SD card slot of a PC or an external USB-to-SD adapter.

Make very sure to use the correct `/dev/` entry. Accidently using a wrong entry may damage your system!

The resulting `<path-to-SD-device>` depends on your system. It is something like `/dev/sdb`, or `/dev/mmcblk0`.

The `<path-to-image>` is the image file you created in the previous build step.

1. Write the binary image to the µSD card:

```
sudo dd if=<patch-to-image> of=<path-to-SD-device> bs=1M
status=progress
```

5 Application Usage

By default the system provides a Wi-Fi access point that remote devices can connect to.

The following features can be controlled through a simple-to-use web interface:

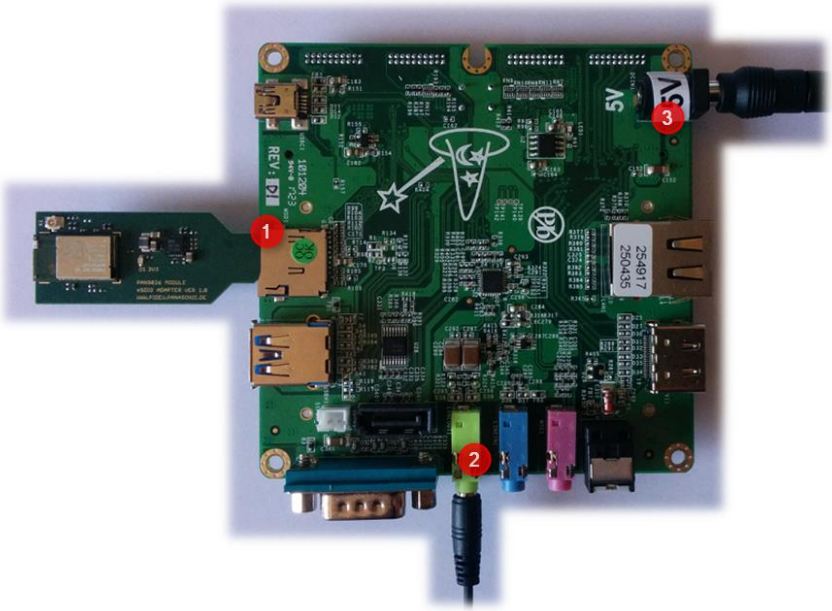
- Provide one wireless network access point (AP)
- Access a wireless network
- Forward IP connections between the different networks
- Bluetooth Classic for A2DP audio streaming
- Bluetooth LE for beacon functionality

No additional peripherals are needed.

5.1 Setup

The following components are needed:

✓ Wandboard with µSD card containing the Yocto Project Linux image
✓ PAN9026-MSD with µSD card form factor
✓ Headphones with 3.5 mm jack
✓ Power supply

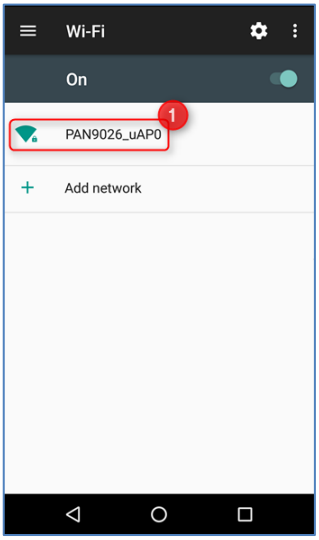


1. Insert the **µSD card** containing the Yocto Project Linux image as explained in ⇨ 3.1 Boot Card Setup.
2. Insert the **PAN9026-MSD** into the µSD card slot of the Baseboard (1).
3. Insert the **headphones with 3.5 mm jack** into the green audio socket (2).
4. Insert the **power supply** (3).

   ➔ The system will boot up. This takes approximately one minute.

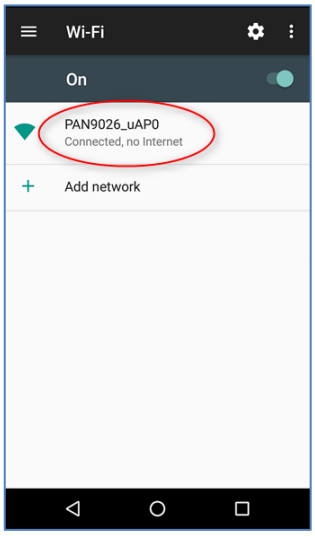
5.2 Connecting to the Access Point

1. Navigate to the Wi-Fi configuration settings of your device and enable Wi-Fi if it is not enabled already.



The access point provided by the PAN9026 module is named `PAN9026_uAP0` and will be found automatically.

2. Click **PAN9026_uAP0** to make the device connect to this access point.
   ➔ The connection is established and is shown as `Connected, no Internet`.

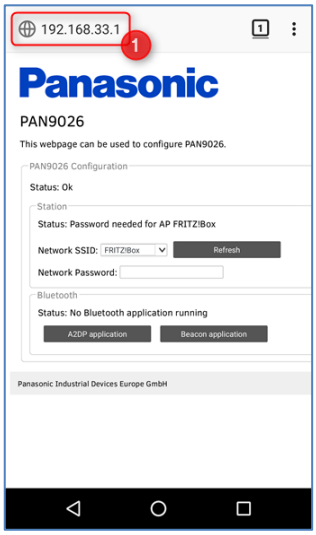


Add this point you can access the PAN9026 module just fine, but cannot use any features that required internet access yet.

5.3 Remote Controlling the PAN9026-IMX

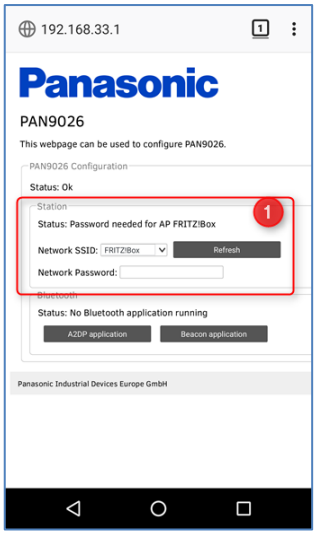
On the PAN9026-IMX a web server is running which provides the user interface for remote controlling the system.

1. Open the **web browser**.
2. Navigate to the address **192.168.33.1** to access (1).



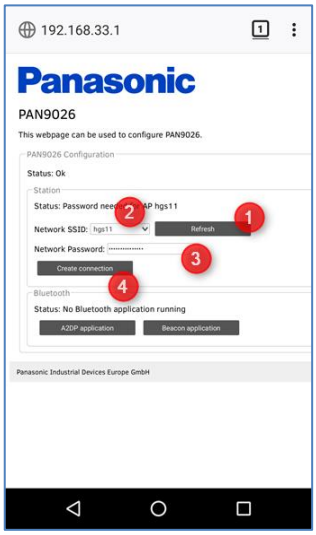
5.4 Exploring the Wi-Fi Features

The Wi-Fi features of the PAN9026 module can be controlled using the **Station** section on the web page (1).



The PAN9026 module is capable of connecting to an existing access point while acting as an access point itself.

The user interface is intuitive and will guide you through the possible use cases.



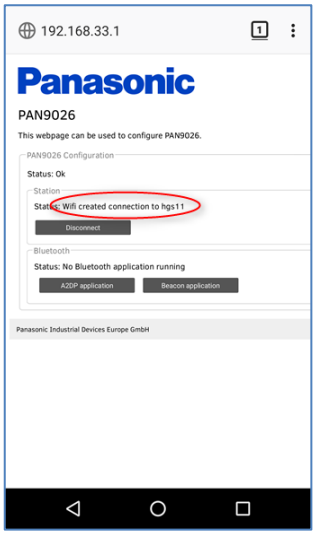
(1) Click **Refresh** to refresh the list of found access points.

(2) Click **Network SSID** to select an access point.

(3) Enter the matching password into the **Network Password** field.

(4) Click **Create Connection** to create the connection.

➔ The PAN9026 module will connect to it. This takes approximately a couple of seconds.

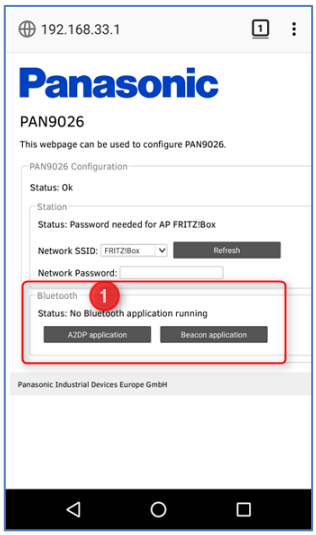


Because the PAN9026 is connected to an access point with internet connection, your device is now able to access the internet through the access point of PAN9026-IMX as well.

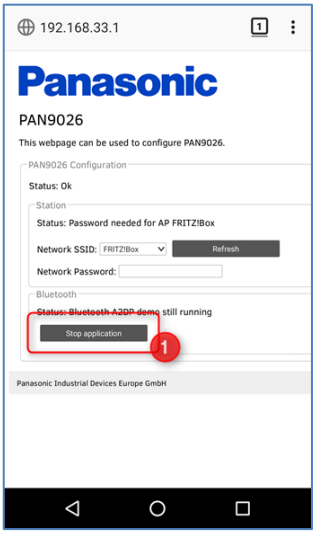
➔ Now you can use another browser window to access any page in the internet, for example `pideu.panasonic.de` (1).

5.5 Exploring the Bluetooth Features

The Bluetooth features of the PAN9026 module can be controlled using the **Bluetooth** section on the web page (1).

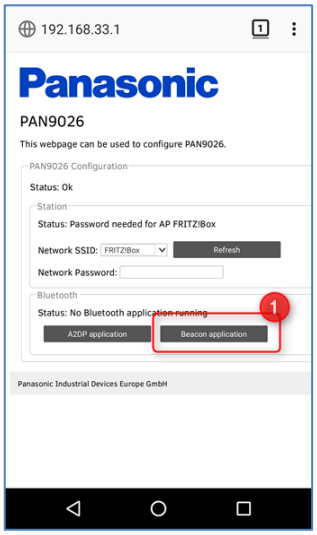


1. Click **Stop application** to stop the currently running Bluetooth application (1).



5.5.1 Bluetooth Low Energy AltBeacon

1. Click **Beacon application** to start the Bluetooth Low Energy AltBeacon application (1).



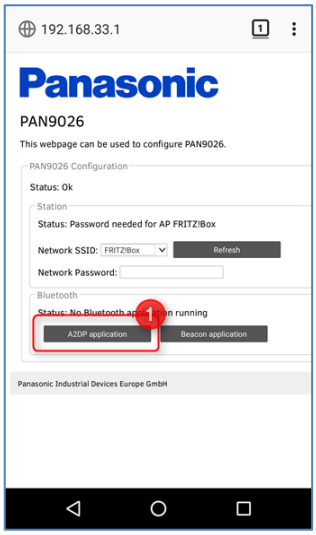
➔ The device is advertising according to the AltBeacon specification.

> You can use the “Locate Beacon” app from “Radius Networks, Inc.” to discover the PAN9026 module.

➔ In the **Locate Beacon** app the PAN9026 module will show up as a regular AltBeacon (1).

5.5.2 Bluetooth Basic Rate A2DP audio sink

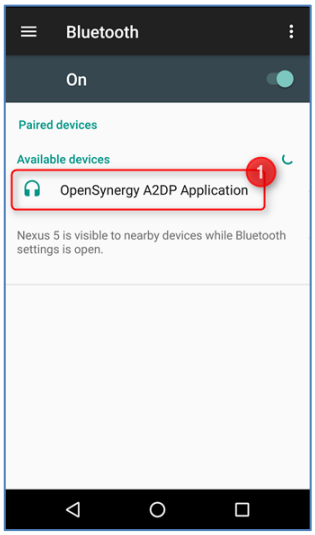
1. Click **A2DP application** to start the Bluetooth Basic Rate A2DP audio sink application (1).



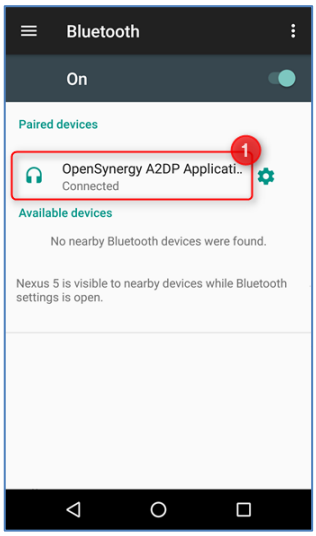
➔ The device is available as an A2DP audio sink.

2. Navigate to the **Bluetooth settings** of your device. Make sure that Bluetooth is enabled.
3. Click on the entry to connect to the PAN9026 module (1).

Usually the PAN9026 module will show up as `OpenSynergy A2DP Application`.



➔ The connection is established and is shown as `Connected` (1). This takes approximately a couple of seconds.



➔ Now any audio that is played back on the Android device is routed to the PAN9026 module instead and output on the audio jack of the PAN9026-IMX.

In order to verify the correct operation, start an application that will output sound, for example, an audio player, a video stream or a web radio or video from the internet.

➔ You should be able to hear the audio when you have connected some headphones to the green audio jack of the Wandboard.

If your Android device is still connected to the access point of the PAN9026 module, make sure that the PAN9026 module itself is connected to an access point with internet access; otherwise no playback from the internet is possible.

6 Background Information

The Yocto Project Linux build is based on the environment as provided by Freescale. For further information please refer to https://github.com/Freescale.

The “rocko” release of the Yocto Project Linux is used.

The files and subfolders in `sources/meta-pideu/` contain some adoptions and changes to the regular build which is discussed in the following chapters.

6.1 Distribution Configuration

All features related to a graphical user interfaces have been removed to speed up the build process. Additionally “system” is activated and “libc” features have been added.

See file: `./sources/meta-pideu/conf/machine/pan-imx.conf`

One of the Freescale layers will remove the “x11-backend” of “gtk+3” as soon as “Wayland” is part of the distro-features because only one graphics backend is supported.

This will lead to some seemingly illogical error messages and failing builds for graphical tools.

This can be solved by removing “Wayland” from the distro-features.

6.2 Base Image Configuration

The `image-pideu.bb` recipe contains the description of an enhanced core image.

It adds additional (custom) packages for the Marvell driver installation as well as additional packages that are necessary for Bluetooth and Wi-Fi connectivity.

See file: `./sources/meta-pideu/recipes-core/images/image-pideu.bb`

6.3 Kernel-Specific Configuration

The kernel default `config defconfig` is altered to enable routing.

See file: `./meta-pideu/recipes-kernel/linux/linux-fslc_4.14.bbappend`

6.4 Addition of Marvell Drivers

The sources for the Marvell drivers and utilities are separated in multiple archives, which in turn are contained in one collective archive.

These separate archives, when uncompressed all in the same directory, create a folder structure, which is needed by the Marvell sources, to be compiled.

To fulfill these dependencies for the individual drivers/utilities, all the recipes for Marvell sources contain a distinct `do_unpack_extra` step, executed after the unpacking of the Marvell archive.

In this step, the separate archives needed for the current module/utilities are unpacked and the needed content is copied in the recipes working directory.

The kernel modules are built in a different way than the utilities, so they needed to have separate recipes.

The Marvell kernel modules and the utilities needed adaptions in the `Makefiles` to be able to be compiled with `Bitbake`. The required changes mostly originate in differences in the naming of environment/configuration variables.

As a result, patches for the `Makefiles` were created and added to the recipes.

The kernel modules should be loaded at start up, so the recipes contain the corresponding `KERNEL_MODULE_AUTOLOAD` and `KERNEL_MODULE_PROBECONF` settings.

The utilities modules needed a change in the way their artifacts were installed into the image. That lead to the recipe files having an overwritten `do_install()` routine to take care of that.

The SD8977 kernel module – which is part of the mlan-module recipe, and which is responsible for the firmware download to the Marvell chip – needs some parameters for its initialization.

Therefore the recipe contains a configuration `module_conf_sd8977` containing the module load parameters.

These settings include `drv_mode=3` to deactivate the `wfd` (Wi-Fi Direct) interface.

The `wlan_app` utilities needed `glibc`, so that dependency is added to the recipe.

The Bluetooth character mode “fmapp” application needs special LD-flags to build, so the recipe contains a corresponding setting.

See files:

`./meta-pideu/recipes-kernel/kernel-modules/kernel-module-marvell-wlan-app.bb`

`./meta-pideu/recipes-kernel/kernel-modules/kernel-module-marvell-btc-fmapp.bb`

`./meta-pideu/recipes-kernel/kernel-modules/kernel-module-marvell-bt8977.bb`

`./meta-pideu/recipes-kernel/kernel-modules/kernel-module-marvell-wlan8977.bb`

`./meta-pideu/recipes-kernel/kernel-modules/kernel-module-marvell-btc8977.bb`

6.5 DHCP Configuration

Instead of using the default configuration file that comes with the `dhcp` recipe a custom configuration is used.

See file: `./meta-pideu/recipes-connectivity/dhcp_%.bbappend`

6.6 ALSA Configuration

The Bluetooth sample applications use “alsa” directly instead of using “Pulseaudio”.

Unfortunately the default volume level of the “Wandboard’s sgtl5000 line out” is very low.

To have a more convenient setting, the recipe `alsa-state` is appended with a patch, adding a default configuration for the sgtl5000 sound card with 0dB (~60 %) setting.

See file: `./meta-pideu/recipes-bsp/alsa-state.bbappend`

6.7 Web Server Configuration

The recipe for the “lighttpd” web server was changed to include the necessary file for the web interface.

See file: `./meta-pideu/recipes-extended/lighttpd_%.bbappend`

6.8 Bluetooth Applications

The utility programs “a2dp_sink” and “iBeacon_app”, which are used to demonstrate Bluetooth abilities of the PAN9026 module, are not open source.

These applications use OpenSynergy’s Blue SDK 5.5 and Low Energy SDK 2.5.

For further information please refer to http://www.opensynergy.com/en/products/blue-sdk.

The application a2dp_sink supports A2DP 1.3.1 and integrates a SBC codec. It allows external Bluetooth clients to pair by using the “Just works” pairing mechanism. After pairing the external device can stream audio. By default the audio signal is routed to the line-out connector.

The application “iBeacon_app” emits a beacon according to “AltBeacon” protocol specification.

For further information please refer to https://github.com/AltBeacon/spec.

The beacon data can be visualized by using Android applications like “Locate Beacon” by “Radius Networks, Inc”.

The applications are added in binary form in their recipes.

See files:

`./meta-pideu/recipes-opensynergy/opsy-ibeacon-app-binary_1.0.0.bb`

`./meta-pideu/recipes-opensynergy/opsy-a2dp-sink-binary_1.0.0.bb`

6.9 Custom Service

One purpose of the demo image is to provide an access point using the PAN9026's µAP feature.

To achieve this, a service `pan-hostapd` is added to the “system” configuration of the target.

The individual steps of starting and stopping the access point and configuring the IP forwarding are available in specific shell scripts named `pan-hostapd-start.sh` and `pan-hostapd-stop.sh`, which is installed to `/usr/sbin` on the target.

The actual AP is configured using Marvell’s `uaputl`. The necessary configuration file can be found in `/usr/sbin/config/uaputl.conf`.

See file: `./meta-pideu/recipes-opensynergy/opsy-demo-hostapd_1.0.0.bb`

7 Contact Details

7.1 Contact Us

Please contact your local Panasonic Sales office for details on additional product options and services:

For Panasonic Sales assistance in the **EU**, visit

https://eu.industrial.panasonic.com/about-us/contact-us

Email: wireless@eu.panasonic.com

For Panasonic Sales assistance in **North America**, visit the Panasonic “Sales & Support” website to find assistance near you at

https://na.industrial.panasonic.com/distributors

Please visit the **Panasonic Wireless Technical Forum** to submit a question at

https://forum.na.industrial.panasonic.com

7.2 Product Information

Please refer to the Panasonic Wireless Connectivity website for further information on our products and related documents:

For complete Panasonic product details in the **EU**, visit

http://pideu.panasonic.de/products/wireless-modules.html

For complete Panasonic product details in **North America**, visit

http://www.panasonic.com/rfmodules