MA35D1 Evaluation Board Quick Start

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Agenda

- Target Platform Introduction
- Overview
- Environment Setup
- Build Image by Buildroot
- Build Image by Yocto
- Image Programming and System Boot
- Fast Application Development

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Target Platform Introduction

MA35D1 Application Processor

System

- Dual 64/32-bit Arm® Cortex®-A35 core running up to 1 GHz with 32/32 KB L1 I/D cache each one, 512 KB shared L2 cache, Arm® NEONTM and Arm® Trust Zone®, Trusted Secure Island
- A 32-bit Arm® Cortex®-M4 core running up to 180 MHz with 16/16 KB I/D cache, FPU/MPU
- Built-in 128/256/512 MB DDR2/DDR3L SDRAM in LQFP/BGA package

Features

- Supports LCD Display controller, 2D Graphic Engine, H.264 decoder for HMI display
- Two CCIR656/601 Camera interfaces
- Two 10/100/1000 Mbps Ethernet MACs
- USB 2.0 high-speed host/device
- Supports AES-256, SHA-512, ECC-571, RSA-4096
- CAN-FD interfaces
- UART, ISO-7816 interfaces, Quad-SPI, SPI, I^2C, I^2S
- EPWM, 12-bit SAR ADC, 32-bit timers
- RTC (Real Time Clock), 32.768 kHz Oscillator
- WDT (Watchdog Timer), WWDT(Window)
- True Random Number Generator (TRNG)

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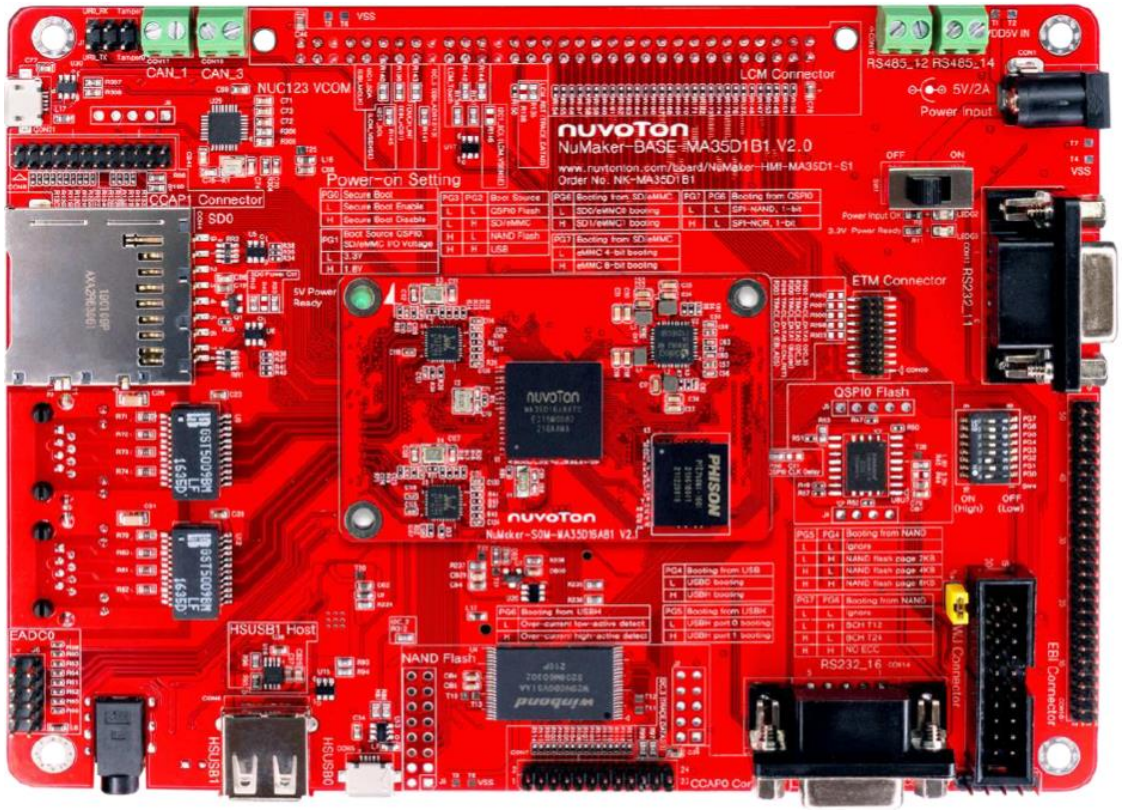
NuMaker-HMI-MA35D1-S1 Features

Features

- MA35D16A887C (BGA312) MCP package with DDR3L (256 MB)
- 7-inch TFT LCD (1024x600) with touch daughter board
- An on-board eMMC (SD3.0) Flash memory device (16 GB)
- An on-board Quad SPI NAND Flash device (512 MB)
- An on-board NAND Flash device (1 GB)
- Standard-SD (SD2.0) memory card slot
- 2 x Giga Ethernet
- 2 x High Speed USB
- 2 x Camera Capture (CMOS sensor) header connectors
- 1 x Audio codec (NAU88C22)
- 2 x UART, 2 x RS485, 2 x CAN-FD, 8 x EADC channels



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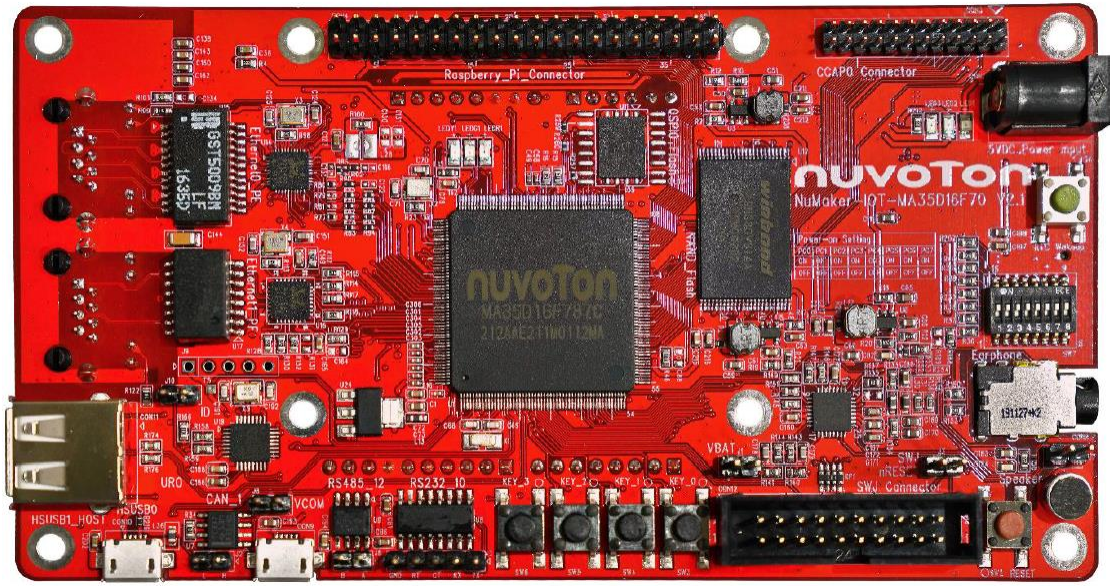
NuMaker-IoT-MA35D1-A1 Features

Features

- MA35D16F987C (LQFP216) MCP package with DDR (512MB)
- Run up to 800MHz operating speed
- An on-board Quad SPI NAND Flash device (512 MB)
- An on-board NAND Flash device (1 GB)
- Standard-SD memory card (SD1, supports SD2.0)
- 1 x Giga Ethernet, 1 x 10/100 Ethernet
- 2 x High Speed USB
- 1 x Camera Capture (CMOS sensor) header connectors
- 1 x Audio codec (NAU88C22)
- 1 x SIM Card slot
- 2 x UART, 2 x RS485, 2 x CAN-FD, 8 x EADC channels



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Quick Start Material

- Level 1 Quick Start
  - MA35D1 Application Processor
  - Evaluation Board and Demo
  - NuWriter_MA35 Programming
- Level 2 Development Environment
  - Development Environment set up
  - GUI development environment set up
  - Hardware Design Notice
- Level 3 Key Features
  - TF-A
  - OP-TEE
  - Real Time Processor
  - VC8000 Video Decoder

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Document

- Nuvoton provides many documents to help users develop quickly
- User Manual
  - UM_NuMaker_HMI_MA35D1_S1
  - UM_NuMaker_IoT_MA35D1_A1
- Schematic, PCB and Gerber file
  - NuMaker-IoT-MA35D1-A1 Schematic, PCB , Gerber file & BOM
- Datasheet
  - MA35D1 Series Datasheet

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Document

- Software User Manual
  - UM_EN_MA35D1_BSP
  - UM_EN_MA35D1_Buildroot
  - UM_EN_MA35D1_Linux_BSP
  - UM_EN_MA35D1_NAND
  - UM_EN_MA35D1_NuWriter
  - UM_EN_MA35D1_OP-TEE
  - UM_EN_MA35D1_RTP
  - UM_EN_MA35D1_TF-A
  - UM_EN_MA35D1_U-boot
  - UM_EN_MA35D1_Yocto

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Document

- Application Note
  - MA35D1_NAND Chip Support_EN
  - MA35D1_Coprocessor_Management_EN
  - MA35D1_Hardware_Design_Guide_EN
  - MA35D1_PMIC_DA9062-3A_EN
  - MA35D1_Secure_Boot_EN
  - MA35D1_TSI_EN
- FAQ
  - FAQ_MA35D1_Extend Boot Space
  - FAQ_MA35D1_NuWriter Issue
  - FAQ_MA35D1_Read MAC Address from OTP
  - FAQ_MA35D1_Show Logo when booting by Yocto
  - FAQ_MA35D1_Switch booting source

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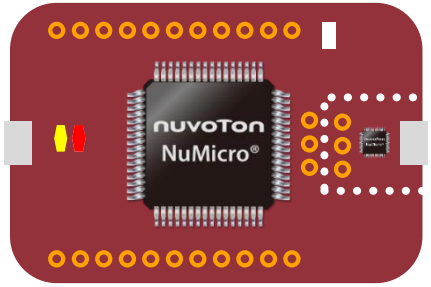
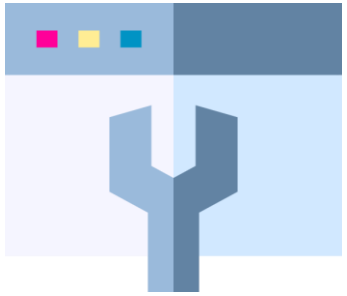
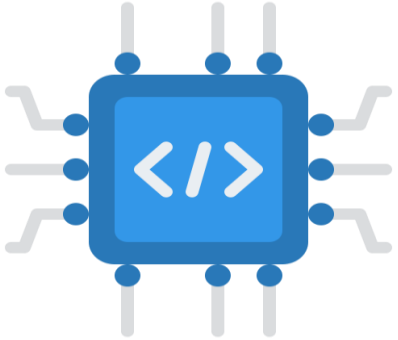
Overview

MA35D1 Development Environment Overview







Evaluation Board (NuMaker)	Software Tool (NuTool)		Board Support Package				M4 Real Time Processor	
General	Programming	General	Operating System	Compiling Tool	Security	General	Example Code	Compiling& Debugger
NuMaker-HMI-MA35D1-S1 NuMaker-IoT-MA35D1-A1	NuWriter NAND Writer Auto Writer	PinConfigure Memory Configure	Linux RT-Thread	Yocto Project Buildroot OpenWRT Env (RT-Thread) Docker	ARM-Trusted-Firmware OP-TEE Trusted Secure Island	Peripheral Drivers Reference Guide Sample Code U-Boot	Designed with NuMicro Family	Nu-Link2-Pro Keil MDK

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MA35D1 Development Environment

- Development environment
  - Docker container – Ubuntu 20.04 : virtual machine in Linux OS
- Development Tools
  - Yocto Project – Build a Linux distribution (MA35D1 Kernel) or an application
  - Buildroot – Build a Linux distribution (MA35D1 Kernel) or an application
  - OpenWRT – Build a Linux distribution (MA35D1 Kernel) or an application
  - NuWriter – Nuvoton provides a tool to program image to storage media
  - NuTool-PinConfigure – Nuvoton provides a tool to define pin Configure
- Image
  - Kernel – Linux 5.10
  - U-Boot v2020.07
  - OPTEE v3.9.0
  - ARM Trusted Firmware v2.3

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Quick Start Building

Preparation → **Environment** → **Compiling** → **Programming**

- PC specification
  - CPU: I5-10400
  - RAM: 16G
  - Storage: SSD 200G
- Operating System
  - Linux

- Download Docker
- MA35D1 Docker Script
- Start MA35D1 Docker
- Download Yocto/Buildroot

- Configuration
  - NuMaker-HMI-MA35D1
  - NuMaker-IoT-MA35D1
- Compiling
  - core-image-minimal
  - nvt-image-qt5

- NuWriter Tool
  - USB
  - NAND
  - SD/eMMC
  - SPI Flash
- System boot

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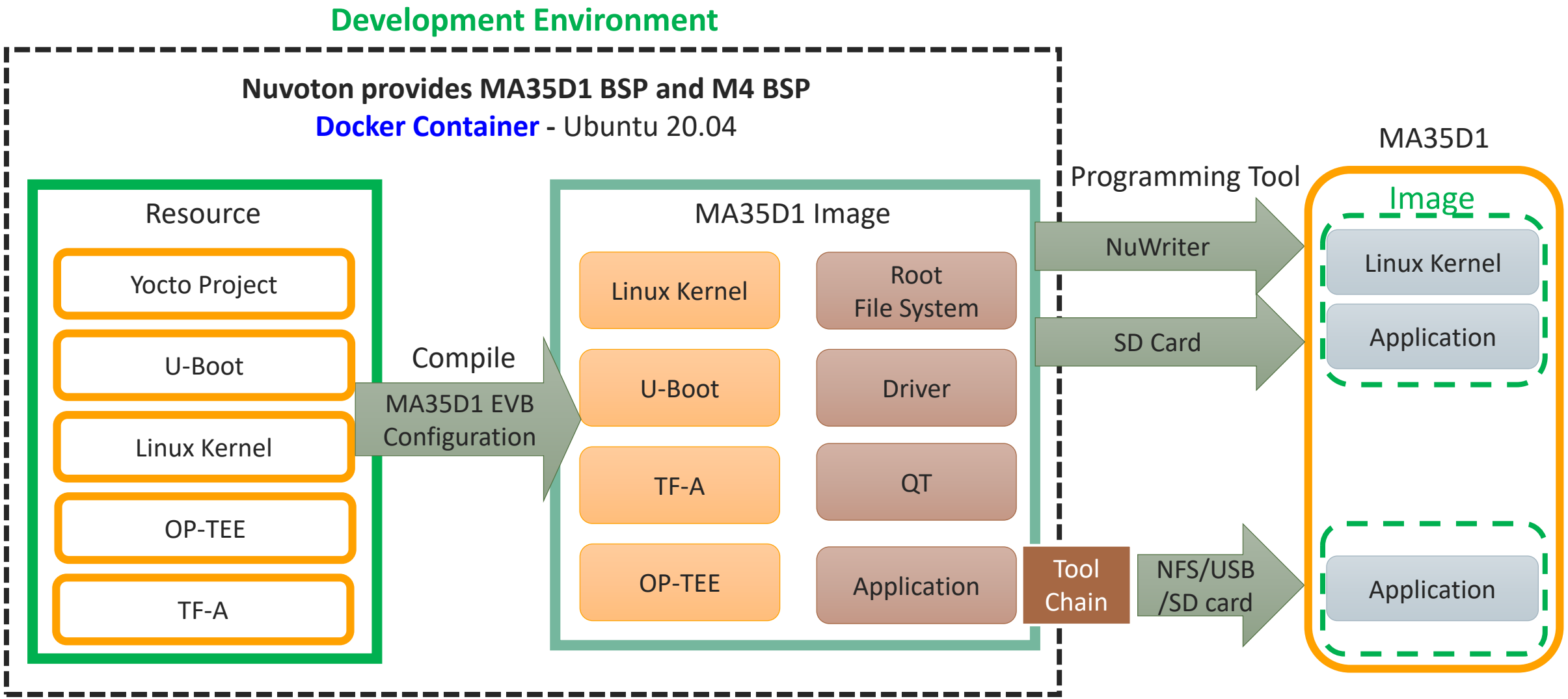
MA35D1 Development Scheme



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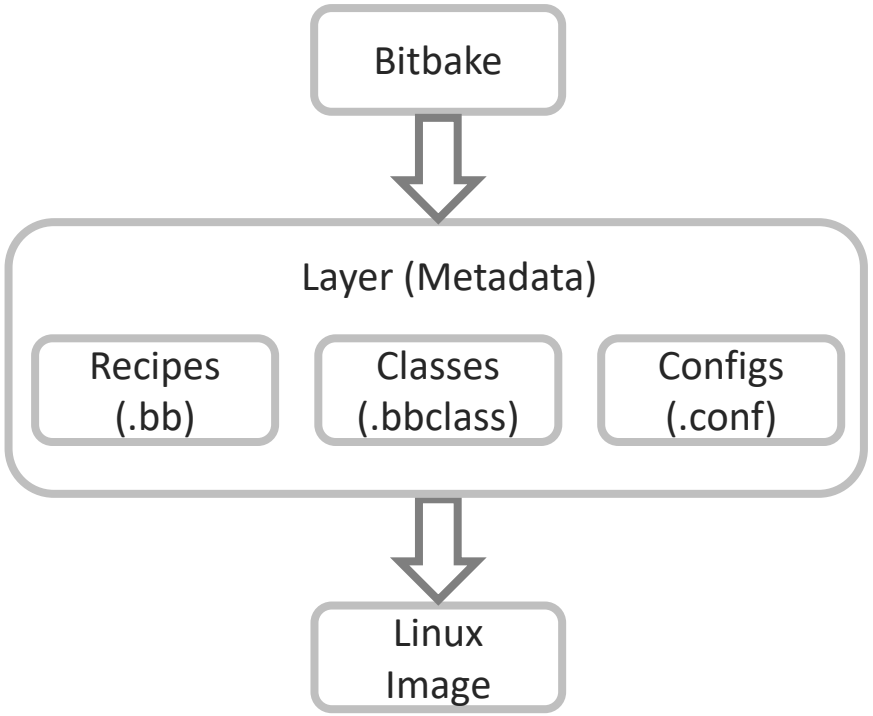
MA35D1 Linux Development Tools – Yocto

- The Yocto Project is an open source collaboration project that helps developers create custom Linux-based systems regardless of the hardware architecture
- MA35D1 Yocto includes the following Metadata
  - Meta-ma35d1
  - Meta-qt5
  - Meta-virtualization
  - Meta-Pocky



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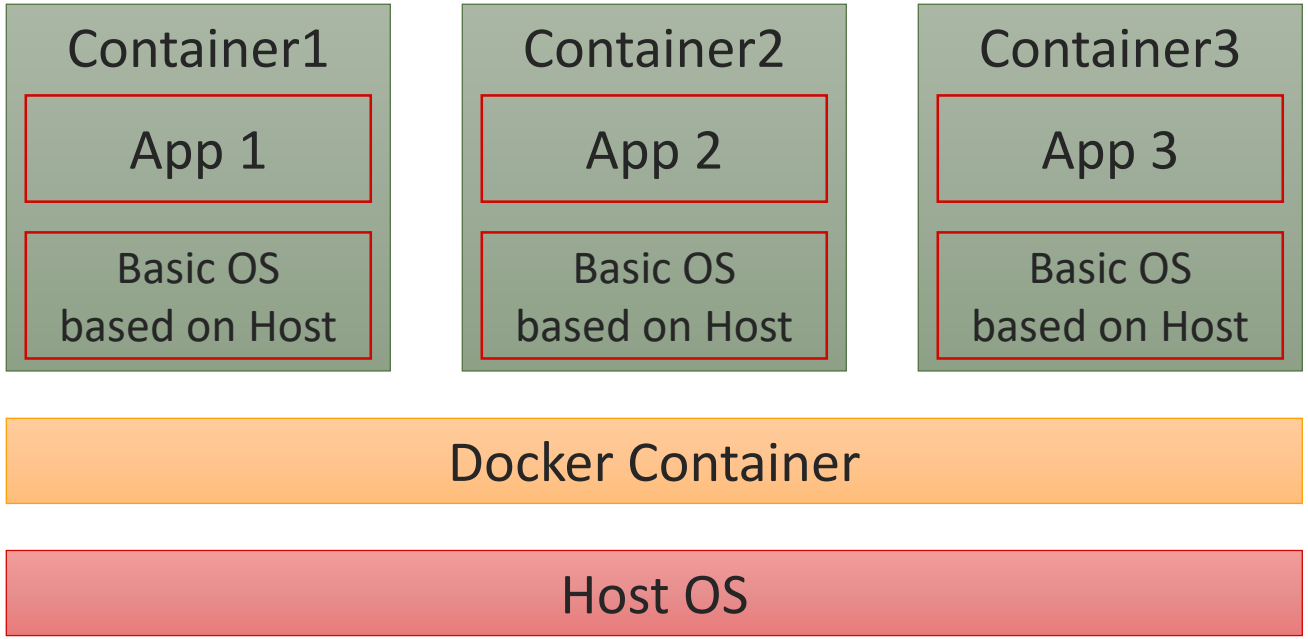
Yocto Development Environment – Docker

- Docker can pack up code and its dependencies as a container
- Every container is independent and based on Host OS so they won't affect each other and run faster than virtual machine



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MA35D1 Linux Board Support Package

- This BSP supports Linux operating system for MA35D1. The peripheral drivers are also included in the BSP allowing applications to access them

Component	Description
Yocto	Version 3.1.3 (Dunfell). A Linux Foundation collaborative open source project to create the Linux distributions
Buildroot	Buildroot is a simple, efficient and easy-to-use tool to generate embedded Linux systems through cross-compilation
OpenWrt	The OpenWrt Project is a Linux operating system targeting embedded devices
Linux	Version 5.10 An open source operating system based on GPLv2 license
U-Boot	Version 2020.07. An open source bootloader based on GPLv2+ license
OP-TEE	Version 3.9.0. An open source trusted execution environment
TF-A	Version 2.3. A BSD-3-Clause license reference implementation of secure world software
M4 BSP	CMSIS library 4.5.0 and standard driver for RTP BareMetal/FreeRTOS firmware development
NuWriter	A GUI and command line tool supports firmware update and OTP programming for MA35D1

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MA35D1 Development Tool Optimization

- Nuvoton provides various tools to help users develop their own MA35D1

Name	Description
NuWriter_MA35	Program Image to MA35D1
NuLink-Pro	Debug real time processor
Pin Configure	Define MA35D1 multifunctional pin
AutoWriter	Program Image to MA35D1 by SD/USBH
DDR Tuning	A DDR configure tool, which can fine tune DDR timing according to PCB layout
NuWriter_MA35 1 to 8 Programming	Support 1 to 8 parallel programming for mass production
RMA Tool Board	IC debug tool
NAND Writer	Program Image to NAND Flash

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MA35D1 Programming Tool – NuWriter

- Download NuWriter for MA35D1 :
  - https://github.com/OpenNuvoton/MA35D1_NuWriter
- The NuWriter is a programing tool for the MA35D1. The NuWriter application and firmware code are open sourced, and users can add new features or develop new user interfaces per user's application.
- USB host (mass storage) is also supported in mass production version
- The MA35D1 supports the following four system boot-up conditions:
  1. Boot from USB
  2. Boot from SD/eMMC
  3. Boot from NAND
  4. Boot from SPI Flash

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Environment Setup

Environment Setup

- PC Spec:

  CPU i5-10400、16GB DDR、1TB SSD
- The Yocto project needs at least 150 GB but we recommend 200 GB up
- If you are a beginner, we recommend Buildroot to build MA35D1 Image
- Nuvoton provides VMware Image which have been installed related packages to build MA35D1 Image
- Download VMware Image

  After downloading the virtual machine, you can skip these following steps to Start up with VMware

  This VMware Image also can be used to build Image by Buildroot

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Environment Setup (1/5)

- The necessary packages must be installed before building
- Ubuntu and Debian

```
$ sudo apt-get install gawk wget git-core diffstat unzip texinfo gcc-multilib \
  build-essential chrpath socat cpio python python3 python3-pip python3-pexpect \
    xz-utils debianutils iputils-ping libsdl1.2-dev xterm curl
```


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Environment Setup (2/5)

- This demo is under Ubuntu distribution. If you use virtual machine, ensure your RAM at least 5GB
- Update existing list of packages

```
$ sudo apt-get update
```

- Install a few prerequisite packages which let apt use packages over HTTPS

```
$ sudo apt install apt-transport-https ca-certificates curl software-properties-common
```

- Add Docker’s official GPG key for the official Docker repository to your system

```
$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add
```

- Set up the stable repository, add the Docker repository to APT sources

```
$ sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubuntu focal stable"
```


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Environment Setup (3/5)

6. Update the package database with the Docker packages from the newly added repo

```
$ sudo apt-get update
```

7. Install Docker

```
$ sudo apt-get install docker-ce docker-ce-cli containerd.io
```

8. Download the Docker Script for MA35D1

```
$ git clone https://github.com/OpenNuvoton/MA35D1_Docker_Script.git
```

```
user@ubuntu:~/MA35D1_Docker_Script$ ls
build.sh  Dockerfile  join.sh  README.md
```


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Environment Setup (4/5)

9. Enter docker-yocto folder, build docker image.It may take one hour to get about 710 files

```
$ ./build.sh
```

10. Enter docker image, and your command line head will be like nuvoton@a24d9e06abe3:~$

```
$ ./join.sh
ma35d1_user
nuvoton@a24d9e06abe3:~$
```


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Start up with VMware

- This VMware Image provides a MA35D1 Linux development environment

  User Name: user
  Password: user

- Yocto:

```
$ cd ~/yocto
 ~/yocto$ repo sync
```

- Buildroot:

```
$ cd ~/buildroot/MA35D1_Buildroot
~/MA35D1_Buildroot$ git pull
```


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Build Image by Buildroot

Buildroot Image by Buildroot

- Remember enter the Docker container and download MA35D1 Buildroot

```
$ git clone https://github.com/OpenNuvoton/MA35D1_Buildroot.git
```

- Choose evaluation board which you want to build the Image
- You can find the board information in the /configs folder

```
$ make numaker-iot-ma35d16f90_defconfig
```

- Start to build the Image

```
$ make
```

- After building, the Image will be in the /output/image folder
- Start to program: Image Programming and System Boot

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Build Image by Yocto

Environment Setup (5/5)

- Create a folder name yocto under /shared

```
nuvoton@a24d9e06abe3:~/share$ mkdir yocto
```

- The first time you use repo, you need to set up the GIT environment

```
nuvoton@a24d9e06abe3:~/shared/yocto$  git config --global user.email "test@test.test.test"
nuvoton@a24d9e06abe3:~/shared/yocto$  git config --global user.name "test“
nuvoton@a24d9e06abe3:~/shared/yocto$  git config --global http.sslverify false
```

- Go to /share/yocto to setup repo path

```
nuvoton@a24d9e06abe3:~/share/yocto$ repo init -u
https://github.com/OpenNuvoton/MA35D1_Yocto-v3.1.3.git -m meta-ma35d1/base/ma35d1.xml
```

- Download the yocto project and update ma35d1 source code

```
nuvoton@a24d9e06abe3:~/share/yocto$ repo sync
```


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Build Image by Yocto (1/3)

1. Setup building configuration. The DISTRO option we usually use nvt-ma35d1-directfb

```
~/yocto$ DISTRO=nvt-ma35d1-directfb MACHINE=numaker-som-ma35d16a81 source  sources/init-build-env build
```

After typing this command and if you want to change this setting, please modify /build/conf/local.conf
If you exit the docker container and join the docker container again, source the environment variables

```
~/yocto$ source sources/init-build-env build/
```

- Usage:
  - MACHINE=<machine> DISTRO=<distro> source sources/init-build-env <build-dir>
    <machine> machine name <distro> distro name <build-dir> build directory
- Choose which DISTRO configuration you want to build
  - nvt-ma35d1-directfb (sources/meta-nua3500/conf/distro/nvt-ma35d1-directfb.conf)
- Choose which machine configuration you want to build
  - numaker-som-ma35d16a81 (sources/meta-ma35d1/conf/machine/ numaker-som-ma35d16a81)
  - numaker-iot-ma35d16f70 (sources/meta-ma35d1/conf/machine/ numaker-iot-ma35d16f70)
  - numaker-iot-ma35d16f90 (sources/meta-ma35d1/conf/machine/ numaker-iot-ma35d16f90)

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Build Image by Yocto (2/3)

- Choose what Image you want to build

Image name	Target	Layer
core-image-minimal	A small image that only allows a device to boot.	Poky
nvt-image-qt5	Builds ma35d1 image	meta-nua3500

- Here we choose nvt-image-qt5 to build image
- This step take about 3hrs first time (download and compile)

```
$ bitbake nvt-image-qt5
```

- After compiling completed, you can see image at

```
~/yocto/build/tmp-glibc/deploy/images/ma35d1-som-ma35d16a81/
```


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Build Image by Yocto (3/3)

- Update Yocto Project

```
nuvoton@a24d9e06abe3:~/share/yocto$ repo sync
```

- Update Linux
- Notice that, the command below will delete all Linux source code and download the newest source code and compile.

```
nuvoton@a24d9e06abe3:~/share/yocto/build$ bitbake linux-ma35d1 –c cleanall && bitbake linux-ma35d1
```

- Clean the old Image and build the newer Image

```
$ bitbake nvt-image-qt5 –c cleanall && bitbake nvt-image-qt5
```


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Image Programming and System Boot

Image Programming and System Boot

- Nuvoton provide two method to program Image to evaluation board
  1. Program image to SD card
  2. Program image to any storage in evaluation board with NuWriter
- First way is a quick way to evaluate application because of programming time less than second way
- The power on setting could be referred to MA35D1 user manual

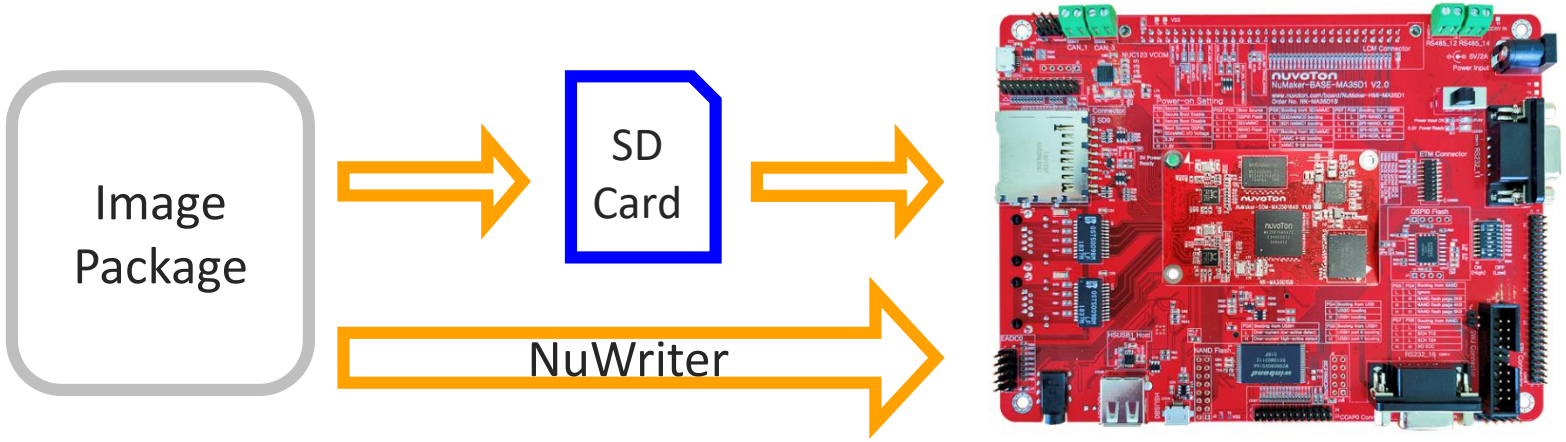

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Image Programming and Boot from SD Card

- Leave the Docker container or create a new command window

```
$ nuvoton@a24d9e06abe3:~$ exit
```

- Format your SD card first and search the SD card number

```
$ sudo fdisk -l
```

```
Disk /dev/sdb: 14.4 GiB, 15489564672 bytes, 30253056 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x00000000
```

- Copy the image to SD card

```
$ sudo dd if=nvt-image-qt5-numaker-som-ma35d16a81.sdcard of=/dev/sdb
```

- After copying, insert the SD card to evaluation board, switch power setting to SD Booting, and boot
- Login password: root

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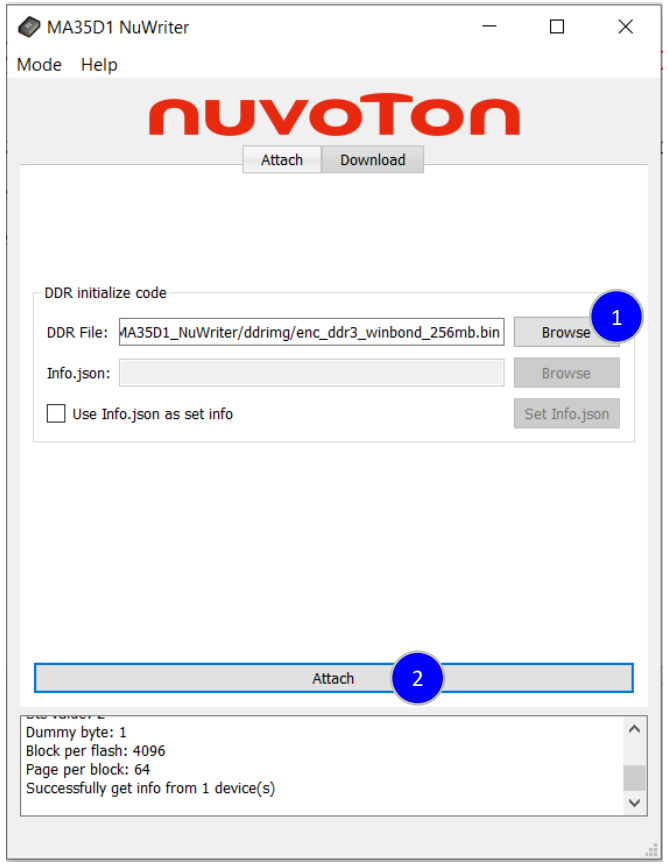
NuWriter Setting and Image Programming (1/5)

- Connect the USB port and switch Power on Setting to USB booting
- Open nuwriterUI.exe or nuwriterUI.py, and attach the DDR parameter
- Step:
  1. Boot from USB
  2. Browse DDR File
  3. Attach
- Notice:

  Remember install WinUSB4NuVCOM.exe and close virtual machine (VMware)



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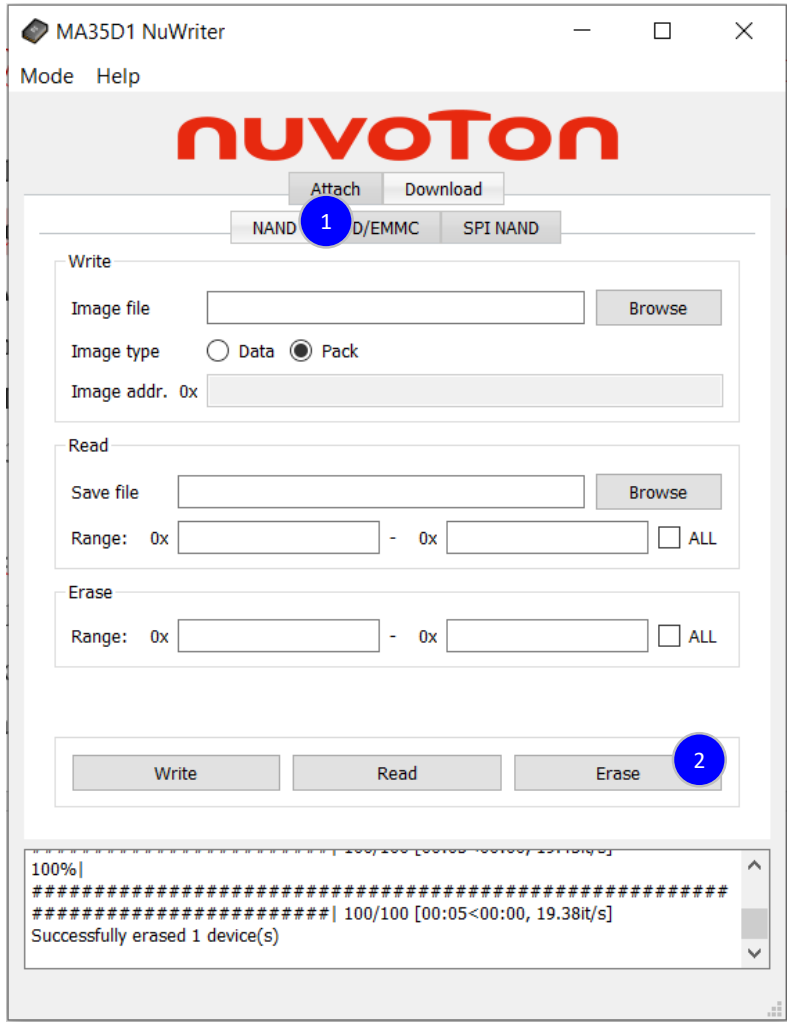
NuWriter Setting and Image Programming (2/5)

~/yocto/build/tmp-glibc/deploy/images/numaker-som-ma35d16a81/

- NAND:
  - pack-core-image-minimal-numaker-som-ma35d16a81-nand.bin
- SPI-NAND:
  - pack-core-image-minimal-numaker-som-ma35d16a81-spinand.bin
- SD:
  - pack-core-image-minimal-numaker-som-ma35d16a81-sdcard.bin
- Erase the flash you want to program to (NAND)
  - Choose NAND
  - Erase



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NuWriter Setting and Image Programming (3/5)

- Program NAND flash
  - Choose Download
  - Choses NAND
  - Browse NAND Package
  - Image: Pack
  - Write

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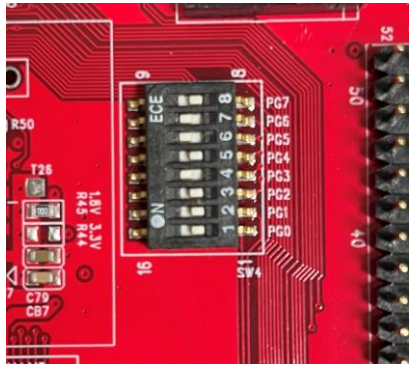
NuWriter Setting and Image Programming (4/5)

- Switch the power setting to boot from NAND flash



- Push the reset button, and MA35D1 will boot from NAND flash

```
Nuvoton Release Distro 5.5-dunfell numaker-som-ma35d16a81 ttyS0

numaker-som-ma35d16a81 login: root
```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NuWriter Setting and Image Programming (5/5)

- This method recommend to the advanced developer
- If you want to replace part of Image package like Linux kernel or DTB, refer to below files

~/yocto/build/tmp-glibc/deploy/images/numaker-som-ma35d16a91/nuwriter

- pack-nand.json
- pack-sdcard.json
- pack-spinand.json

- The three files show the details of every part of Linux package

  You can replace the part of Image by NuWriter

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Fast Application Development

Setup Compiler by Yocto (1/2)

- Set up cross-compile environment can reduce some developing time, because you don't need to use Yocto re-build the whole Linux image and program it. After use MA35D1 toolchain to compile and program it to evaluation board, you can execute it directly on evaluation board.
- Make a toolchain installer, and it may take about 1 hour

```
$ bitbake nvt-image-qt5 -c populate_sdk
```

- Go to the following path and execute the shell file

```
~build/tmp-glibc/deploy/sdk $ ./oecore-x86_x64-aarch64-toolcahin-5.5-dunfell.sh
```

```
Nuvoton Release Distro SDK installer version 5.5-dunfell
Enter target directory for SDK (default: /usr/local/oecore-x86_64):
You are about to install the SDK to "/usr/local/oecore-x86_64", P[Y/n]?
Extracting SDK . . . . . done
Setting it up . . .
Each time you wish to use the SDK in a new shell session, you need to source the environment setup script e.g.
```


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Setup Compiler by Yocto (2/2)

- Add toolchain to environment variables

```
$ source /usr/local/oecore-x86_64/environment-setup-aarch64-poky-linux
```

- Create the source code file for this example: helloworld.c

```
#include <stdio.h>
int main() {
   // printf() displays the string inside console
   printf("Hello, World!\n");
   return 0;
}
```

- Compile it

```
$ $CC helloworld.c -o helloworld
```

- Move the binary file to MA35D1 evaluation board and execute it

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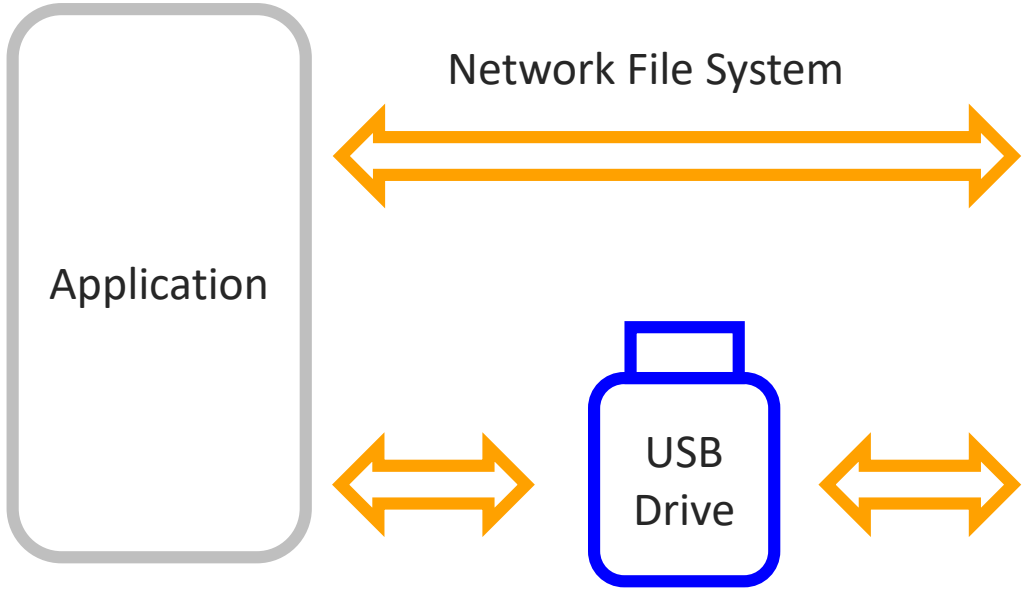
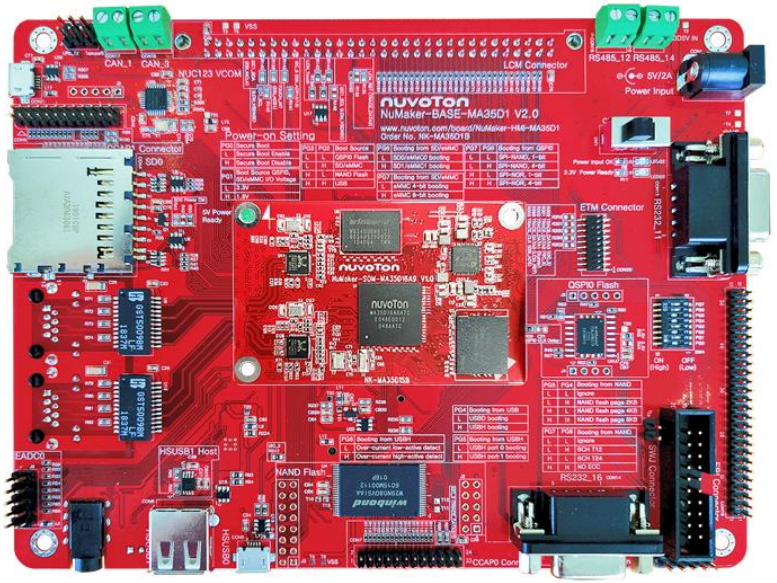
MA35D1 – Application Programming

- There are many ways to program application to evaluation board. Here Nuvoton demonstrates two methods
  - Network File System Programming
  - USB Flash Drive Programming





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Network File System Programming (1/3)

- This can cross-compile the application on PC and execute it on device through NFS rather than build the whole Linux image or use another way to send the application to device.
- The following demo is operate on Ubuntu 20.04 not in the Docker container
- First, install the network file system server on host OS

```
$ sudo apt-get install nfs-kernel-server nfs-common
```

- Create a folder to put your application code and shared with device
- Modify the network file system setting. Add the following statement in exports

```
$ sudo gedit /etc/exports
Add ” *(The folder path you want to share)*(EVB’s IP ADDRESS)(rw,sync,no_root_squash, no_subtree_check) ”
```

```
/home/user/yocto/helloworld 192.168.0.100(rw,sync,no_root_squash,no_subtree_check)
```

- Restart the network file system service

```
$ sudo /etc/init.d/nfs-kernel-server restart
```


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Network File System Programming (2/3)

- Enable NFS client in Linux kernel

```
~/build$ bitbake linux-ma35d1 -c devshell
~/build/tmp-glibc/work-shared/ma35d1-evb/kernel-source# make menuconfig
```

```
File systems  --->
   [*] Enable POSIX file locking API
   [*] Network File Systems  --->
         <*>   NFS client support
         <*>       NFS client support for NFS version 2
         <*>       NFS client support for NFS version 3
         [*]       NFS client support for the NFSv3 ACL protocol extension
         <*>       NFS client support for NFS version 4
```

- Leave the kernel setting

```
~/build/tmp-glibc/work-shared/ma35d1-evb/kernel-source# exit
```

- Add nfs-utils to image and add the command to /build/conf/local.conf

```
IMAGE_INSTALL_append = "nfs-utils"
```

- Re-compile image and program to device

```
~/build$ bitbake linux-ma35d1 -C compile
~/build$ bitbake nvt-image-qt5
```


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Network File System Programming (3/3)

- Create a folder in device terminal

```
root@ma35d1-evb:~# mkdir -p /mnt/nfs
```

- Check the IP address if device and host are in the same internet domain
- Mount the NFS on device

```
mount -o nolock -t nfs 192.168.0.103:/home/user/yocto/build/helloworld /mnt/nfs/
```

- Now, you can find the folder shared with host helloworld folder

```
root@ma35d1-evb:~# ifconfig eth0 192.168.0.100
root@ma35d1-evb:~# cd /mnt/nfs/
root@ma35d1-evb:/mnt/nfs# ls
root@ma35d1-evb:/mnt/nfs# cd ..
root@ma35d1-evb:/mnt# mount -o nolock -t nfs 192.168.0.103:/home/user/yocto/buil
d/helloworld /mnt/nfs/
[   64.473803] NFS: bad mount option value specified: minorversion=1
root@ma35d1-evb:/mnt# cd nfs/
root@ma35d1-evb:/mnt/nfs# ls
hello    hello.c
root@ma35d1-evb:/mnt/nfs# ./hello
Hello World!!
```


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USB Dongle Programming

- After cross-compile the application, you can copy the binary file to USB storage and execute on evaluation board
- Copy the application to USB drive, insert it to evaluation board, and confirm USB device number

```
$ fdisk -l
```

- Create a folder named usb for USB device under mnt folder, and mount on USB device

```
$ mount /dev/sda1 /mnt/usb
```

- Execute the application

```
$ ./hello
```

```
root@ma35d1-evb:/mnt/usb/Helloworld Sample# ls
hello
root@ma35d1-evb:/mnt/usb/Helloworld Sample# ./hello
Hello World!!
```


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Joy of innovation

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谢谢

謝謝

Děkuji

Bedankt

Thank you

Kiitos

Merci

Danke

Grazie

ありがとう

감사합니다

Dziękujemy

Obrigado

Спасибо

Gracias

Teşekkür ederim

Cảm ơn