Porting Mender to New i.MX 8M Plus Machine and Working with Toradex BSP

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Konsulko Group

- Services company specializing in Embedded Linux and Open Source Software
- Hardware/software build, design, development, and training services
- Based in San Jose, CA with an engineering presence worldwide
- http://konsulko.com/

Agenda

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- What is Mender?
- Integrating Mender on new hardware
- Yocto/OE layer meta-mender-community
- Examples with Toradex Verdin
- Conclusions
- Q&A

Common Embedded Linux Update Strategies

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- A/B updates with dual redundant scheme
- Delta updates
- Container-based updates
- Combined strategies

Are there any Mender open source alternatives?

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- RAUC
- SWUpdate
- Swupd
- UpdateHub
- Balena
- Pandacor
- Snap
- Libostree (OSTree)
- Aktualizr
- Aktualizr-lite
- QtOTA
- Torizon
- FullMetalUpdate
- Rpm-ostree (used in Project Atomic)

Combined Update Strategies

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- Container technology has changed the way application developers interact with the cloud and some of the good practices are nowadays applied to the development workflow for embedded devices and IoT. Containers make applications faster to deploy, easier to update and more secure through isolation
- Yocto/OE layer meta-virtualization provides support for building Xen, KVM, Libvirt, docker and associated packages necessary for constructing OE-based virtualized solutions
- There are use cases on powerful embedded devices where **containers** are combined with A/B updates of the base Linux distribution built with Yocto/OE
- There are use cases of delta updates combined with A/B updates

What is Mender?

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- Over-the-air update turn-key end to end solution for Embedded Linux
- Available as a free open source or paid commercial/enterprise plans
- A/B update scheme for open source and all plans as well as delta updates for professional and enterprise plans
- Back-end services (Hosted Mender)
- Source code in GitHub under Apache 2.0
- Compatible with the Yocto Project and binary OS images based on the Debian family

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Mender Supported Devices

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Supported hardware platforms and development boards:

- Raspberry Pi
- BeagleBone
- Intel x86-64
- Rockchip
- Allwinner
- NXP
- And many more in: https://github.com/mendersoftware/meta-mender-community

Typical Mender Partition Layout

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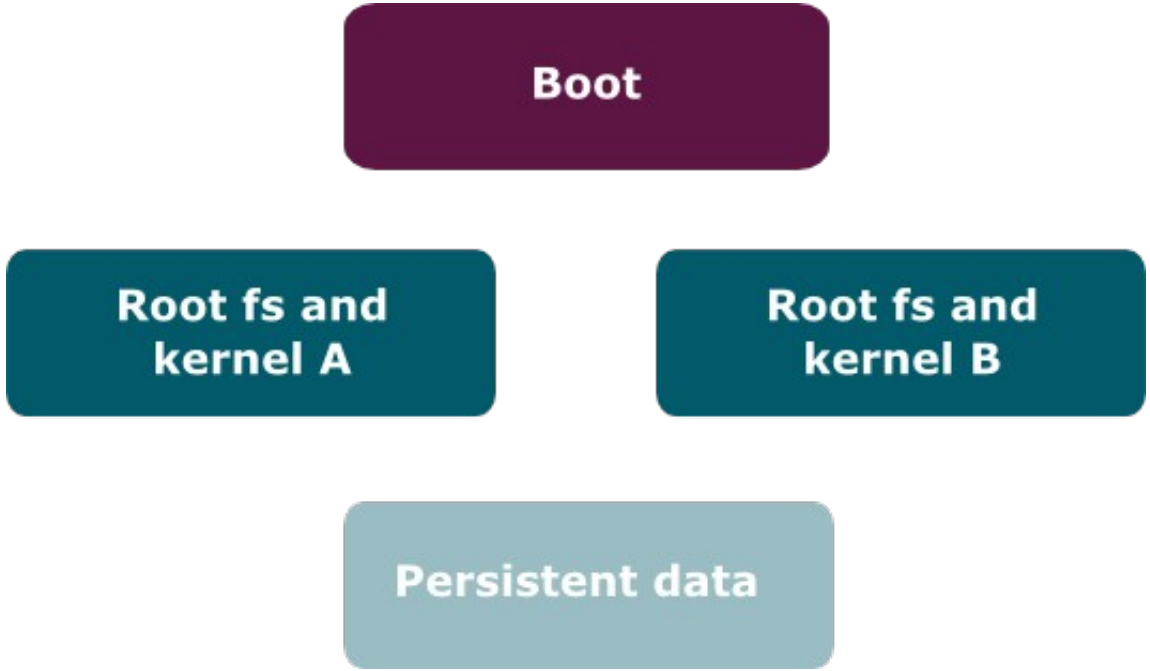

Mender Bootloader Compatibility

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Feature	Supported
GRUB integration for ARM systems	Yes, default
GRUB integration for Flash/UBI devices	No
GRUB integration for x86/UEFI systems	Yes, default
GRUB integration for x86/BIOS systems	Yes
U-Boot integration for ARM systems	Yes
U-Boot integration for Flash/UBI devices	Yes

Mender with x86-64 support

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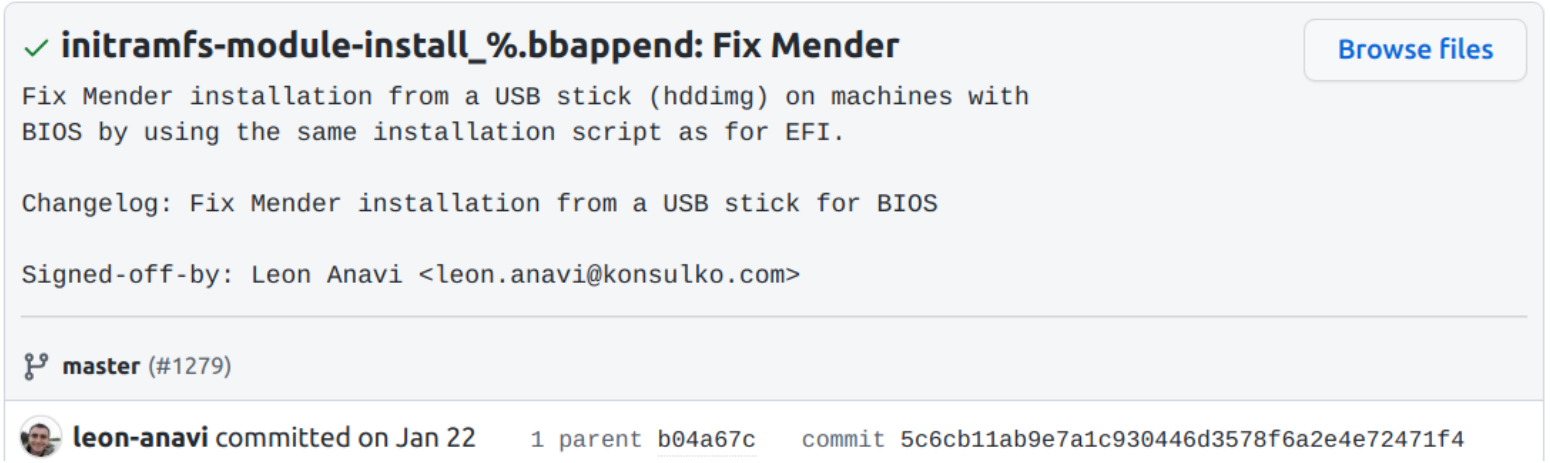
- Mender added support for x86-64 machines through GRUB in 2018
- Initial installation of the distribution is most commonly done using a live image on a USB stick



✓ **initramfs-module-install_%.bbappend: Fix Mender**

Browse files

```
Fix Mender installation from a USB stick (hddimg) on machines with
BIOS by using the same installation script as for EFI.

Changelog: Fix Mender installation from a USB stick for BIOS

Signed-off-by: Leon Anavi <leon.anavi@konsulko.com>
```

master (#1279)

leon-anavi committed on Jan 22 1 parent b04a67c commit 5c6cb11ab9e7a1c930446d3578f6a2e4e72471f4

Mender Data Partition

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- Mender creates a /data partition to store persistent data, preserved during Mender updates.
- The Mender client on the embedded devices uses /data/mender to preserve data and state across updates
- Variable MENDER_DATA_PART_SIZE_MB configures the size of the /data partition. By default it is 128 MB. If enabled, mender feature mender-growfs-data which relies on systemd-growfs tries to resize on first boot with the remaining free space
- It is possible to create an image for the data partition in advance with bitbake:

```
IMAGE_FSTYPES:append = " dataimg"
```

Mender Data Partition

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- Mender data partition supports several file systems: ext4, Btrfs and F2FS
- The file system is set by variable **MENDER_DATA_PART_FSTYPE**

dataimg: Add F2FS support

Browse files

```
Add a new feature to support F2FS (Flash-Friendly File System) for
the data partition with variable MENDER_DATA_PART_FSTYPE_TO_GEN.

Changelog: Support F2FS for the data partition

Signed-off-by: Leon Anavi <leon.anavi@konsulko.com>
```

master (#1646)
kirkstone-v2022.10 kirkstone-v2022.09

leon-anavi committed on Mar 25 — 1 parent 41acb5b — commit a6f519bff741e0887129a628de02a1e141cd5579

Mender Client Modes

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Mender A/B updates supports two client modes:

- Managed (default) - client running as a daemon polls the server for updates
- Standalone - updates are triggered locally which is suitable for physical media or any network update in pull mode

```
SYSTEMD_AUTO_ENABLE_pn-mender = "disable"
```

```
$ cd deploy/images/verdin-imx8mp/
$ python3 -m http.server
Serving HTTP on 0.0.0.0 port 8000 (http://0.0.0.0:8000/) ...
```

```
$ mender -install http://example.com:8000/core-image-weston-verdin-imx8mp.mender
```

Mender Update Workflow

Steps to install Mender A/B update on embedded Device:

- Apply update
- Reboot
- On the first boot after a successful update, though the Mender client a commit must be performed to accept the update (otherwise the system will roll-back on next reboot)

Mender Single File Artifact

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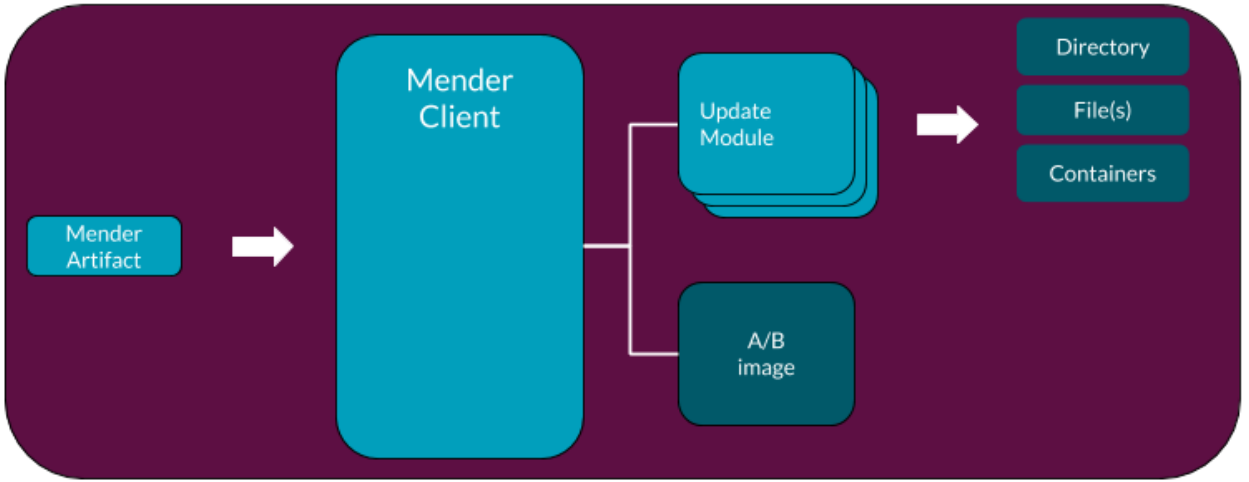
- Deployment of a single file, directory or even a container image is possible through “Application updates”



Mender add-ons

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Mender supports several add-ons:

- **Remote Terminal** - interactive shell sessions with full terminal emulation
- **File Transfer** - upload and download files to and from a device
- **Port Forward** - forward any local port to a port on a device without opening ports on the device
- **Configure** - apply configuration to your devices through a uniform interface

Mender Delta Updates

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- Mender offers robust delta update rootfs as a module for the **commercial** Mender plan (**closed source** implementation)
- Requires reboot to apply the update
- Supports rollback
- Tool mender-binary-delta create a binary delta by comparing 2 different Mender artifacts
- Mandatory requirement for the implementation is a **read-only** root file system

Read-only Root Filesystem

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Yocto and OpenEmbedded offer two options to create a read-only root filesystem:

- Thought the image's recipe file:

```
IMAGE_FEATURES += "read-only-rootfs"
```

- Alternatively, through **local.conf**:

```
EXTRA_IMAGE_FEATURES = "read-only-rootfs"
```

- Beware, there might be packages in the image that expect the root filesystem to be writable and might not function properly. A solution is to move these files and directories to the data partition.

Toradex Verdin iMX8M Plus

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- Verdin iMX8M Plus is a member of Toradex Verdin Family
- NXP i.MX 8M Plus applications processor
- 4GB RAM
- 16GB FLASH
- WiFi and Bluetooth

- Comes with Toradex Easy Installer pre-installed.

Setup Yocto environment

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- Create a directory for the build:

```
mkdir mender-toradex && cd mender-toradex
```

- Select the appropriate Toradex BSP version:

```
export TORADEX_BSP_VERSION=6.0.0
```

- Initialize repo manifest:

```
repo init -u https://git.toradex.com/toradex-manifest.git -b refs/tags/${TORADEX_BSP_VERSION} -m tdxref/default.xml
```

- Download mender manifest:

```
wget --directory-prefix .repo/local_manifests https://raw.githubusercontent.com/mendersoftware/meta-mender-community/kirkstone/scripts/mender-no-setup-layers.xml
```

- Fetch layers in manifest:

```
repo sync -j$(nproc)
```

Setup build environment (1/2)

- Initialize the build environment:

```
. export
```

- Add Mender layers:

```
echo "BBLAYERS += \" \${TOPDIR}/../layers/meta-mender/meta-mender-core \"" >> conf/bblayers.conf
echo "BBLAYERS += \" \${TOPDIR}/../layers/meta-mender-community/meta-mender-toradex-nxp \"" >> conf/bblayers.conf
echo "TORADEX_BSP_VERSION = \"toradex-bsp-${TORADEX_BSP_VERSION}\"" >> conf/local.conf
```

- Add optional Mender demo layer:

```
echo "BBLAYERS += \" \${TOPDIR}/../layers/meta-mender/meta-mender-demo \"" >> conf/bblayers.conf
```

- Apply Mender configuration to build environment:

```
cat ../layers/meta-mender-community/templates/local.conf.append >> conf/local.conf
cat ../layers/meta-mender-community/meta-mender-toradex-nxp/templates/local.conf.append >> conf/local.conf
```

- Accept Freescale EULA and add to your conf/local.conf:

```
ACCEPT_FSL_EULA = "1"
```

Setup build environment (2/2)

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- Add Mender specific configurations for verdin-imx8mp for example in your conf/local.conf:

```
MENDER_BOOT_PART_SIZE_MB = "32"
OFFSET_SPL_PAYLOAD = ""
MENDER_IMAGE_BOOTLOADER_BOOTSECTOR_OFFSET="0"
MENDER_UBOOT_STORAGE_INTERFACE = "mmc"
MENDER_UBOOT_STORAGE_DEVICE = "2"
MENDER_STORAGE_DEVICE = "/dev/mmcblk2"
```

Building the image

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- Build a minimal image:

```
MACHINE=verdin-imx8mp bitbake core-image-weston
```

- After a successful build, the image and Mender artifact are:

```
deploy/images/verdin-imx8mp/core-image-weston-verdin-imx8mp.mender
deploy/images/verdin-imx8mp/core-image-weston-verdin-imx8mp.mender_tezi.tar
```

Toradex Easy Installer

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- Linux-based application with a Graphical User Interface (GUI) for installation images on the internal flash memory of Toradex System on Modules (SoM) from a USB stick or over the network
- The GUI can be accessed directly using a keyboard, a mouse and a monitor or remote via VNC
- Comes pre-installed in Toradex System on Modules (SoM)
- Supports automatic installations

```
TEZI_AUTO_INSTALL = "true"
```

- Advanced options for pre-install, post-install script execution and customized partitioning schemes

Toradex Easy Installer via Zeroconf

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- Toradex Easy Installer is capable of using Zeroconf to find an image server feeds on the local network
- To announce a Toradex Easy Installer image server add an AVAHI service to /etc/avahi/services with the following content:

```
<?xml version="1.0" standalone='no'?>
<!DOCTYPE service-group SYSTEM "avahi-service.dtd">
<service-group>
  <name replace-wildcards="yes">Custom Toradex Easy Installer Feed</name>
  <service>
    <type>_tezi._tcp</type>
    <port>80</port>
    <txt-record>name=Custom Toradex Easy Installer Feed</txt-record>
    <txt-record>path=/path/image_list.json</txt-record>
    <txt-record>enabled=1</txt-record>
    <txt-record>https=0</txt-record>
  </service>
</service-group>
```

How Does it Work?

Yocto/OpenEmbedded BSP layers related to the Mender integration for Toradex Verdin iMX8M Plus:

- **meta-toradex-nxp**
- **meta-mender**
- **meta-mender-toradex-nxp** with u-boot patches for each supported machine

```
u-boot
├── files
│   ├── 0001-Integration-of-Mender-boot-code-into-toradex-U-Boot.patch
│   ├── 0002-use-read-only-rootfs.patch
│   └── toradex-bsp-6.0.0
│       ├── apalis-imx6
│       │   ├── 0001-configs-toradex-board-specific-mender-integration.patch
│       │   └── 0001-Use-mender_dtb_name-for-fdtfile.patch
│       ├── apalis-imx8
│       │   ├── 0001-configs-toradex-board-specific-mender-integration.patch
│       │   └── 0001-Use-mender_dtb_name-for-fdtfile.patch
│       ├── colibri-imx6ull
│       │   ├── 0001-configs-toradex-board-specific-mender-integration.patch
│       │   └── 0001-Use-mender_dtb_name-for-fdtfile.patch
│       ├── colibri-imx8x
│       │   ├── 0001-configs-toradex-board-specific-mender-integration.patch
│       │   └── 0001-Use-mender_dtb_name-for-fdtfile.patch
│       ├── verdin-imx8mm
│       │   ├── 0001-configs-toradex-board-specific-mender-integration.patch
│       │   └── 0001-Use-mender_dtb_name-for-fdtfile.patch
│       └── verdin-imx8mp
│           ├── 0001-configs-toradex-board-specific-mender-integration.patch
│           └── 0001-Use-mender_dtb_name-for-fdtfile.patch
└── u-boot-toradex_%.bbappend
```

Porting Mender new Toradex SoM

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- Use **meta-toradex-nxp** and **meta-mender**
- Apply changes required for new machine in **meta-mender-toradex-nxp**
- Test and perform Mender integration checklist: https://docs.mender.io/client-installation/integration-checklist
- Submit GitHub pull request to **meta-mender-community**
- Share the exact steps how to build a demo image for the new board integration using the Yocto Project and OpenEmbedded through https://hub.mender.io/

Conclusions

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- Mender is a reliable turn-key end to end solution for software updates of Embedded Linux devices featuring a client application and a server
- Mender is available as a free open source for A/B updates or paid commercial/enterprise plans also featuring delta updates of read-only rootfs
- Numerous board integrations exists in **meta-mender-community**, including for Toradex SoMs through the sub-layer **meta-mender-toradex-nxp**
- Toradex SoMs come pre-installed with Toradex Easy Installer which is a Linux-based application with GUI for flashing images on on the internal memory
- To port Mender to a new Toradex SoM in future some changes will be required in **meta-mender-toradex-nxp** in conjunction with BSP from **meta-toradex-nxp**

Thank You!

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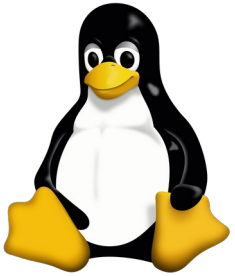

MENDER

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Thanks to meta-mender-community maintainers:

- **Drew Moseley**
- **Josef Holzmayr**

Useful links

- https://docs.mender.io/
- https://hub.mender.io/t/toradex-verdin-imx8m-plus/5026
- https://developer.toradex.com/easy-installer/
- https://www.konsulko.com/how-mender-works/