arm

Xen based Arm Autonomy Stack using Yocto

Linaro Tech Days 2020

Bertrand Marquis, Jon Mason Arm Ltd

March 24th 2020

Presenters

- Bertrand Marquis
  - Principal software engineer at Arm ltd in the Open Source Software group (CE-OSS)
    - Yocto Autonomy Reference Stack
    - Xen on Arm
  - Bertrand.marquis@arm.com
- Jon Mason
  - Principal Yocto Developer at Arm ltd in the Open Source Software group (CE-OSS)
    - Principal maintainer of the meta-arm OpenEmbedded Layer
    - OpenEmbedded Board member
  - jon.mason@arm.com

Summary

- Xen based Arm Autonomy Reference Stack
  - Why and what ?
- meta-arm Yocto Layers
  - How ?
- Current Status and Future

arm

Xen based Arm Autonomy Reference Stack

Hypervisor enabled reference stack

- Autonomy systems are complex
  - Lots of functions
  - Enough computing power
- Hypervisor advantages
  - Easier development and reuse
    - Group common, non-differentiating features into a separate project
    - 3rd parties can focus on value delivery
    - Platform invariant applications
    - Sets a starting point for code reuse at vendor/T1 level
  - Easier deployment
    - Isolate critical from non-critical
    - Control boot flow
    - Easier updates

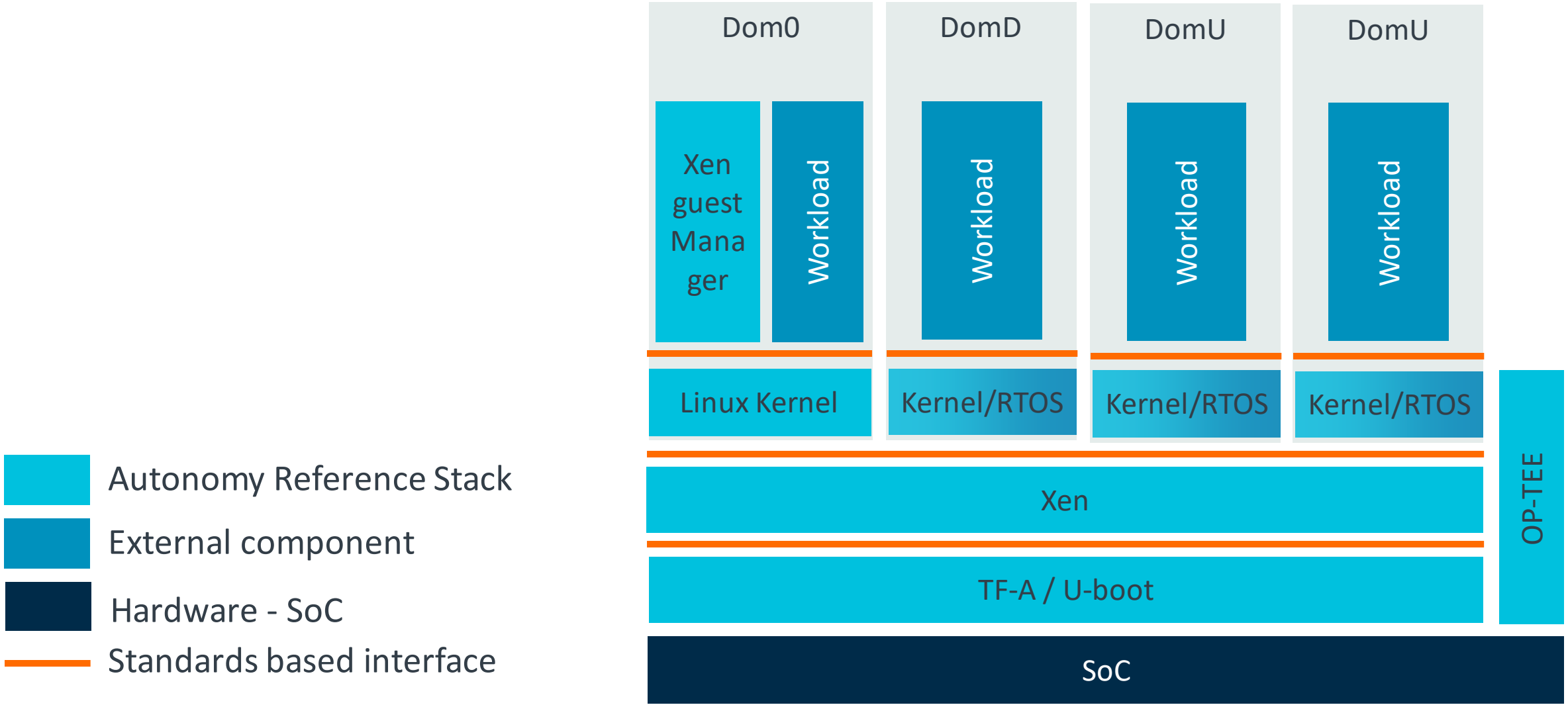
Why Xen

- Xen is a type 1 hypervisor
  - No need to certify Linux or windows
  - Reduced size of code
  - Fast boot time
- Xen is open-source
  - Widely available
  - Strong community
  - Used in number of servers and systems
- Xen community is pushing for this kind of applications
  - FuSa project for Xen certification
  - Automotive/Embedded is a Xen goal
  - Some Industry leaders implicated (Qualcomm, Xilinx, BAE, Bosh, Arm, …etc)

Autonomy reference stack

- Build a Xen based reference stack
  - Suitable for autonomy systems
    - Autonomous driving, robotics,
    - Suitable for safety and/or real-time
  - Focus on boot time and stripped functionalities
  - Small and simple system to create/deploy/start/stop guests
  - Functions to provide safety and security features
    - OP-TEE integration
    - Secure boot
    - Update system
  - Allow easy integration of different components
    - Have guests useable on different systems independently of the hardware

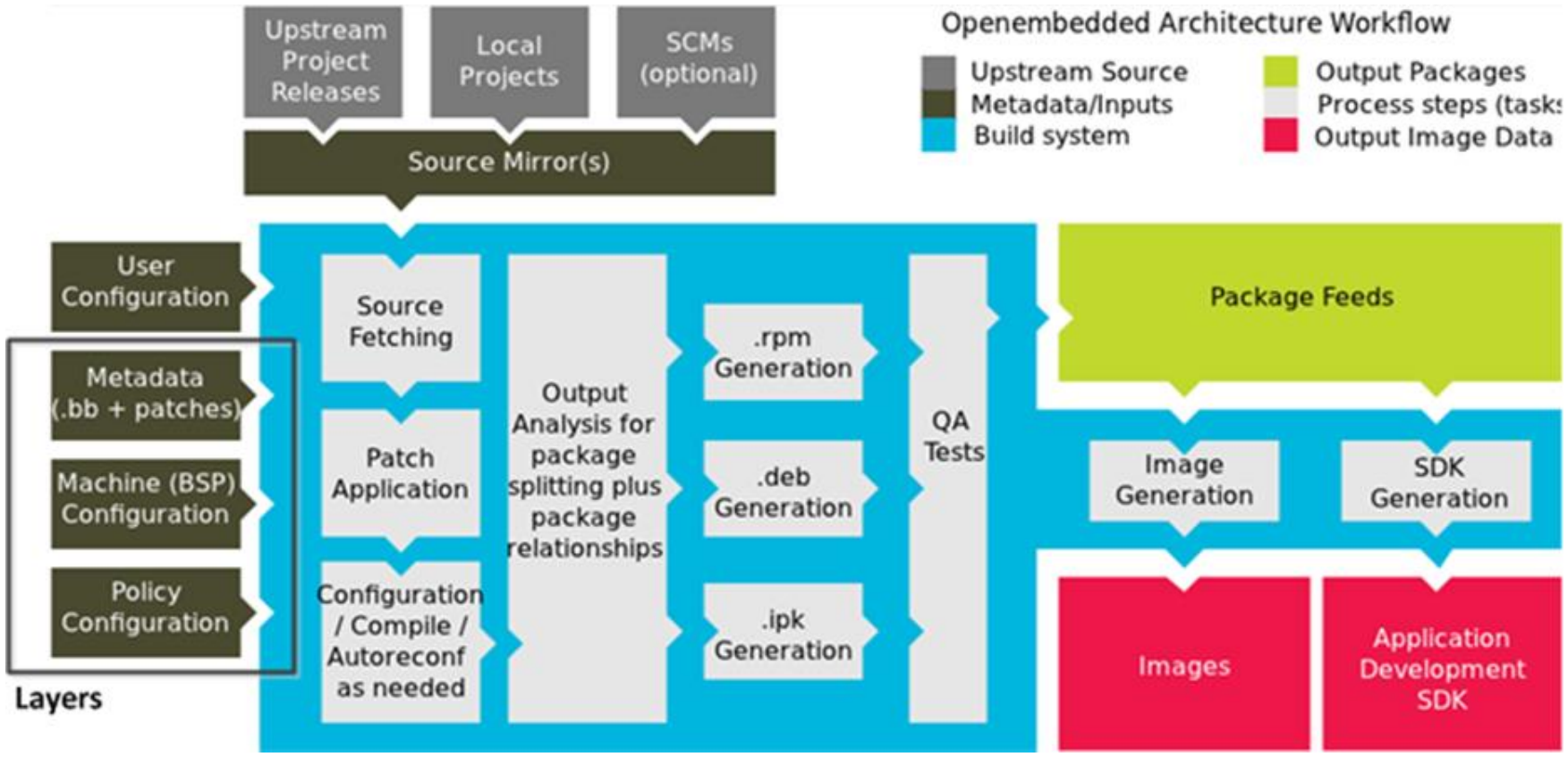
Autonomy reference stack



How do we build a custom reference stack?

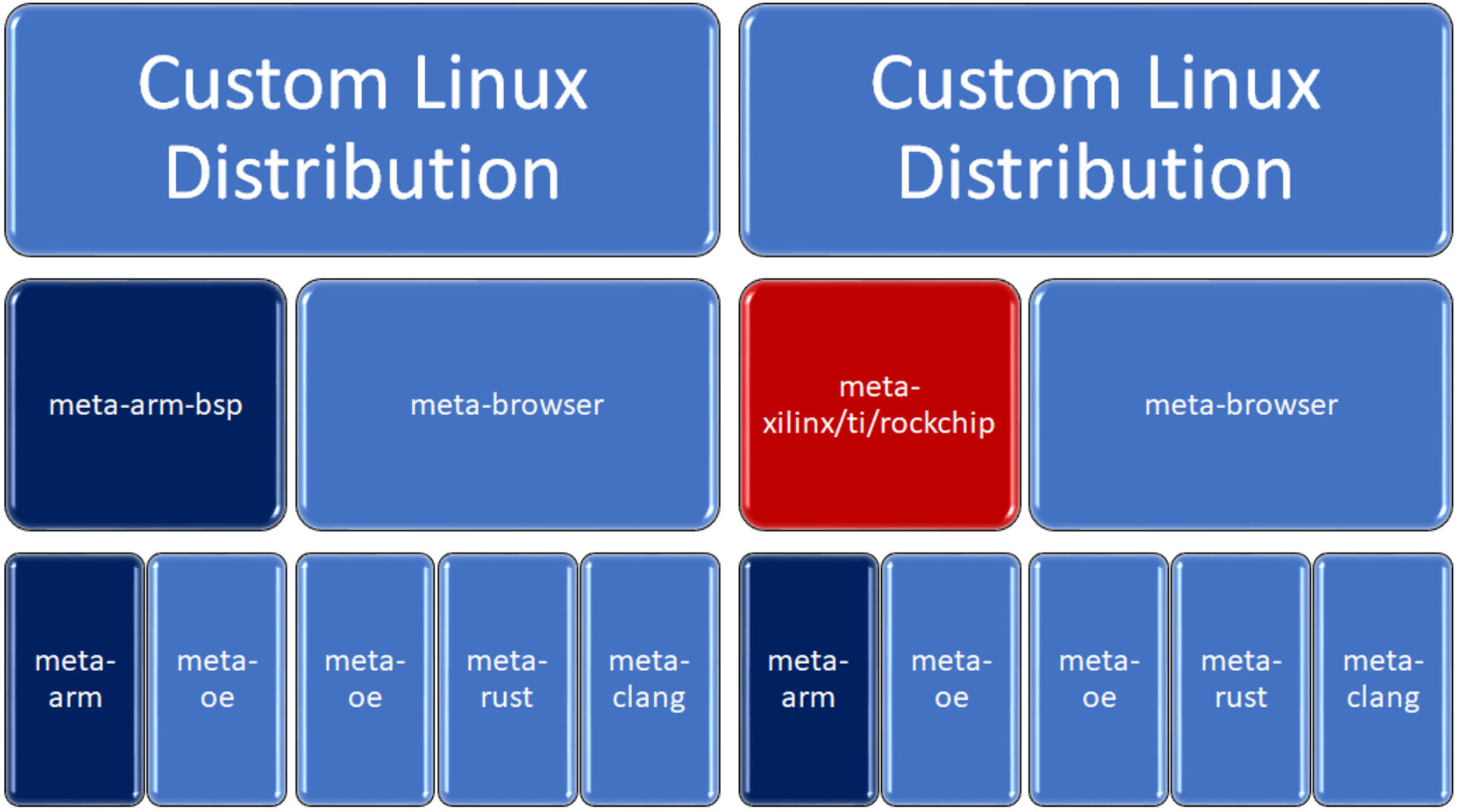
Yocto!

- The Yocto Project is a set of templates, tools and methods that helps you build custom Linux-based systems.



meta-arm Yocto Layers

What is an OpenEmbedded/Yocto Layer?



Why meta-arm collection of layers

- Many Arm vendors have their own unique Yocto meta layer
  - Fragmentation of implementation
    - Divergent recipes
    - Different versions of underlying software
    - No need to upstream (random git tree with their changes on top)
  - Difficult to upgrade to new versions of Yocto and the underlying software (stale)
  - No shared work to maintain the recipes and underlying software
    - And often not thoroughly tested
  - Often not following Arm recommended processes or implementation
    - I.e., not using OP-TEE or secure boot

meta-arm

- Intended to be the "one stop shop" for all Arm Software
  - Arm specific software
  - Reference hardware/BSP enablement
  - Arm Toolchains
  - Autonomy/Automotive
  - Arm Embedded Distro?
- Also intended on being a place to collaborate
- CI constantly run to ensure stability and quality
- Model the behavior for Arm platforms that we want vendors to emulate (and hopefully just copy)

meta-arm

- Name makes it a bit confusing, meta-arm/meta-arm
- This layer provides support for general recipes for the Arm architecture. Anything that's not needed explicitly for BSPs, a distribution, or destined to be upstreamed to another meta layer goes here
- Currently contains recipes for:
  - OP-TEE
  - TF-A
  - OpenSCD

meta-arm-bsp

- This layer provides support for Arm reference platforms
- Currently contains support for:
  - Cortex A5 DesignStart
  - GEM5
  - Juno
  - Foundation Models

meta-arm-toolchain

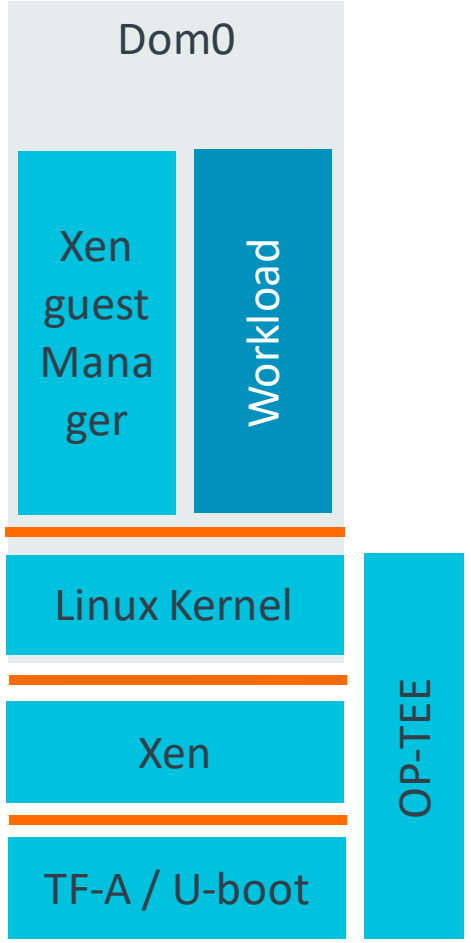
- This layer provides support for Arm's GNU-A toolset releases
- Currently contains support for Arm modified GCC v8.2, v8.3, and v9.2
- Pre-compiled binary toolchains also available for use via this layer

meta-arm-autonomy: Goals

- Autonomy reference stack implementation based on Yocto
- Build all components
  - Host project (Dom0)
  - Guest project (DomU or DomD)
  - Xen
  - Firmware (TF-A, OP-TEE)
- Be useable with other layers
  - Use external BSPs
  - Use existing workloads for guest (AGL, wayland or others)
- Easy to use for fast prototyping and research

meta-arm-autonomy: Host project

- Build a host system:
  - Build Xen (using meta-virtualization)
  - Build a device tree to boot Xen and Dom0
    - Add xen bootargs
    - Add Dom0 multiboot node
  - Build Dom0 Linux
    - Add Xen backend drivers in Linux kernel
    - Xen Dom0 tools
    - Qemu
    - Ssh and networking
- Implemented as a Yocto distribution feature:
  - DISTRO_FEATURES += "arm-autonomy-host"
  - arm-autonomy-host-image-minimal Yocto image packs dom0 minimal components

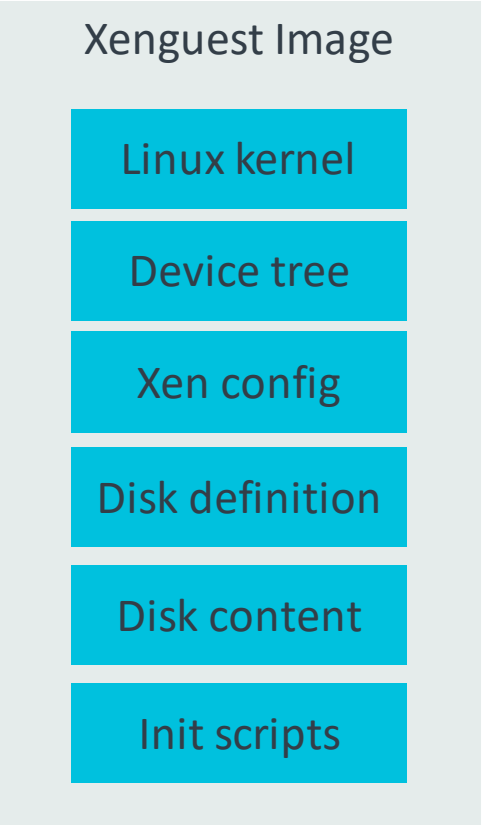


meta-arm-autonomy: Guest project

- Implemented as a Yocto distribution feature:
  - DISTRO_FEATURES += "arm-autonomy-guest"
  - Customize an image to be used as Xen DomU
    - Xen frontend drivers
    - Console on HVC0
  - To be used with any Yocto image (no specific image provided)
- Arm64-autonomy-guest BSP
  - Minimal Kernel configuration (no hardware drivers) to run as Xen DomU
  - Enable arm-autonomy-guest DISTRO_FEATURE
    - if used no need to modify DISTRO_FEATURES
  - Suitable for DomUs only relying on Xen drivers for communication

meta-arm-autonomy: Xenguest System

- Create and manage Xen guests:
  - Xenguest image format:
    - Include all components in one file
    - Xenguest-mkimage tool
      - create/modify/check images
      - useable on development host and on target
  - Xenguest manager
    - Dom0 tool to manage images
    - Create guest from images
      - Create disks using LVM
    - Start/stop guests
      - Create final xen configuration
      - Call init scripts at different steps



meta-arm-autonomy: Xenguest System

- Integration in meta-arm-autonomy:
  - Xenguest image FSTYPE
    - Include rootfs, kernel, xen configuration and init scripts in an image
    - Activated by "arm-autonomy-guest" distro feature
    - Variables can be used to customize it (size of ram, number of cores, command line, etc.)
  - Xenguest-image-extra class to extend the image from other recipes
  - Xenguest-manager
    - Included in "arm-autonomy-host-image-minimal"
    - Init script to boot automatically guests on startup
    - Variables can be used to customize it (disk for LVM volumes, path to guests to include, etc.)
  - Xenguest-network-bridge
    - Create a network bridge on host and connect guests to it
    - Parameter in xenguest image to connect it or not to the bridge

Current status and future

meta-arm Status

- Initial deployment in January 2020
- Initial feedback from Arm Licensees is promising
- Beta of meta-arm-autonomy has been pushed to the mailing list last week !!
- First version to be released with Yocto Dunfell in April

meta-arm future

- More BSPs!
  - Corstone-700
  - Neoverse N1 SDP
  - (more after Q1 2020)
- More Software!
  - EDK2 (UEFI)
  - SCP
  - TF-M
- Enhance meta-arm-autonomy!
  - Boot time and size optimization
  - Security and Updates
  - Easier development
  - Compatibility with other layers (BSPs or workloads)

How to get involved

- More information on Yocto Project
  - https://www.yoctoproject.org/docs/
- Clone and use the layer for all of your Yocto based Arm projects
  - git://git.yoctoproject.org/meta-arm
- Join the meta-arm mailing list
  - https://lists.yoctoproject.org/g/meta-arm

arm

Thank You
Danke
Merci
谢谢
ありがとう
Gracias
Kiitos
감사합니다
धन्यवाद
شكرًا
ধন্যবাদ
תודה

arm