



Linux Plumbers Conference

» Richmond Virginia / Nov. 13-15, 2023

Challenges in Device Tree Sync - kernel, Zephyr, U-boot, System DT

Date: 2023-11-15

Nishanth Menon

About us: TI Processors and Open source



Decades of contribution and collaboration



Ingrained culture to give back to the community



Upstream FIRST!

Focus on long term, sustainable and quality products



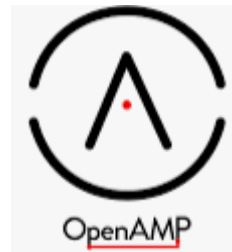
Zephyr®

Upstream and opensource ecosystem in device architecture



U-Boot

Upstream FIRST mentality!



About me

Senior Member Technical Staff at Texas Instruments, Dallas.



- Community member
- U-Boot and kernel.org developer
- Maintainer, TI K3 Device tree
- Just a user of the sink, not the plumber

Disclaimers

- This is a technology presentation, not product-readiness or roadmap commitment
- Opinions presented here are that of the speaker and may not reflect that of Texas Instruments Inc, DT maintainers or any of the software ecosystems.
- This presentation is not going to solve world DT problems.

Overview

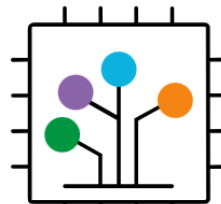
- The Long-short Tale of DT
- Perspectives
- Likes and Dislikes
- Solution? Middle ground?
- Discussion/Q&A



By ToLo46 - Own work, CC BY-SA 4.0,

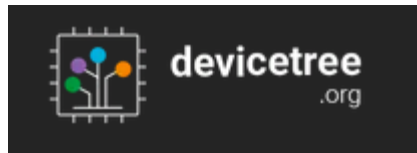
Long short tale of Device Tree

- SPARC/PowerPC antecedents
- See this presentation by Neil Armstrong:
https://elinux.org/images/0/06/ELCE_2019_DeviceTree_Past_Present_Future.pdf
- Device Tree and YAML debates
 - <https://www.konsulko.com/yaml-and-device-tree>
 - <https://static.linaro.org/connect/lvc21f/presentations/LVC21F-315.pdf>
- Device Trees and overlays
 - <https://docs.kernel.org/devicetree/overlay-notes.html>



**Devicetree
Specification**

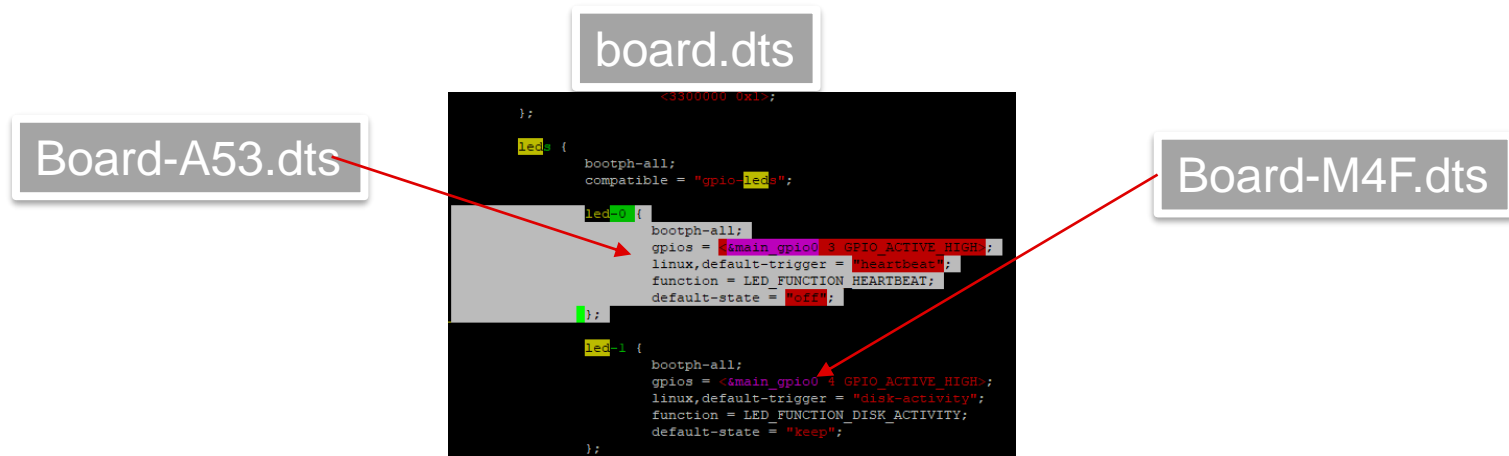
devicetree-specification.readthedocs.io



[The Devicetree Project](https://devicetree.org)

And why exactly did I start this journey?

- Blink an LED from A53 from Linux and another LED from Zephyr running on M4F on AM625 based BeaglePlay
- Wanted to do DT just once! I expected:



- But the solution, apparently, isn't that simple!

The Elephant – AM625

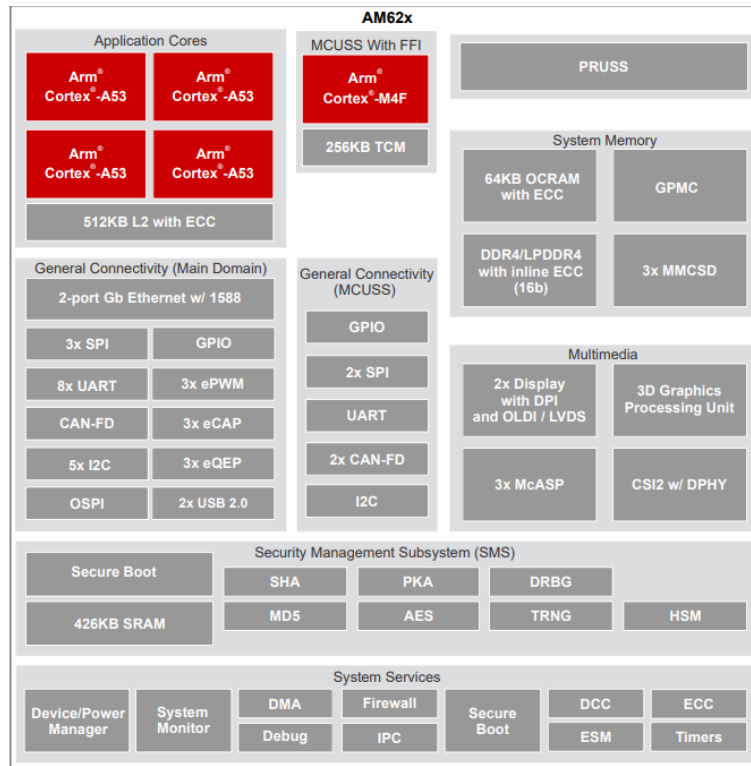
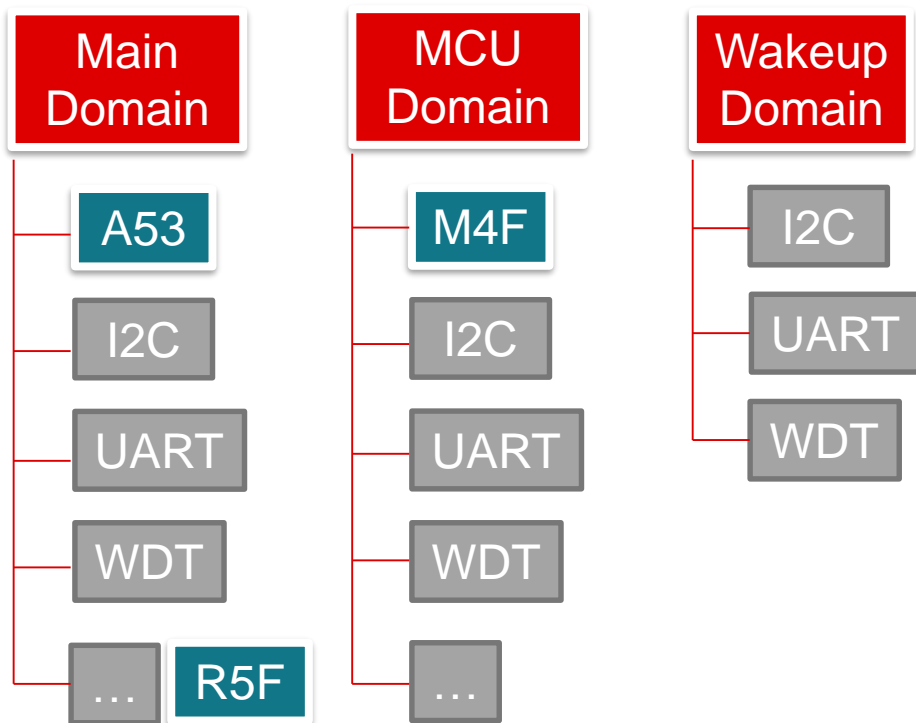
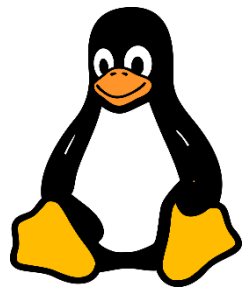


Figure 1-1. Functional Block Diagram

<https://www.ti.com/lit/pdf/spruiiv7> 8

Three views of the Elephant



Penguin People

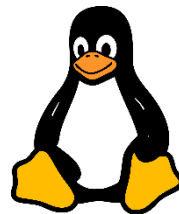


Submarine People



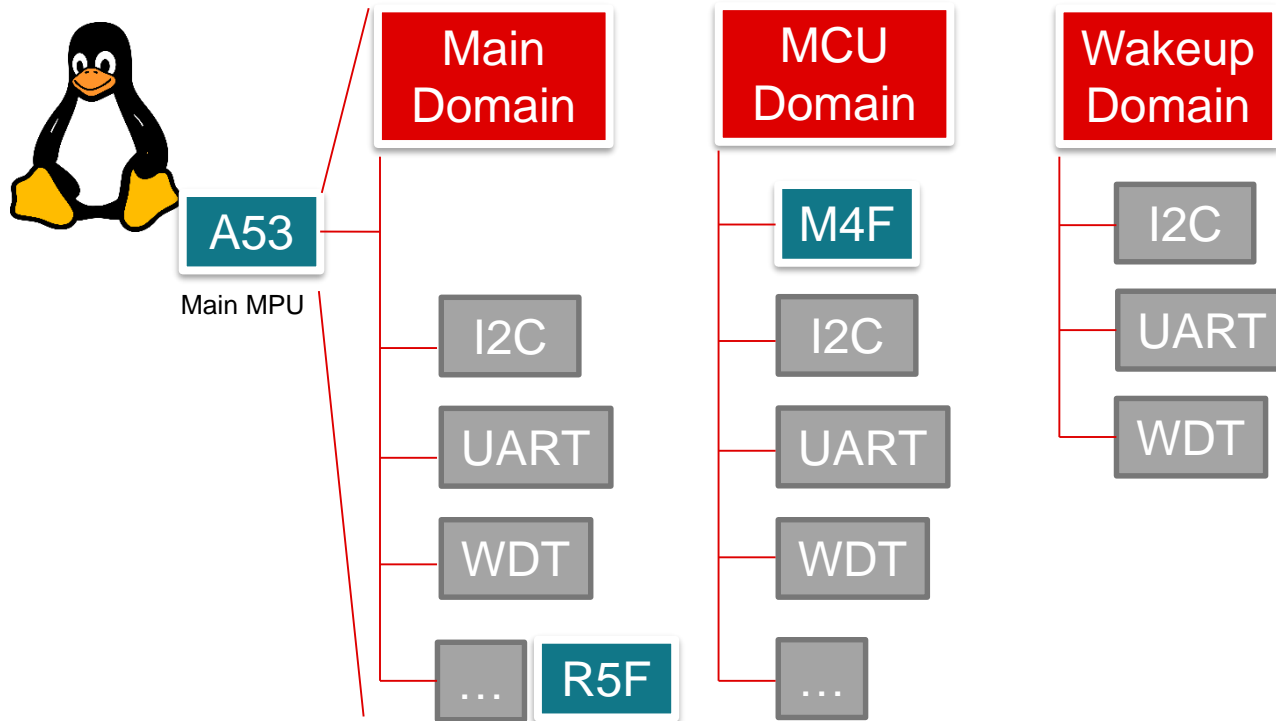
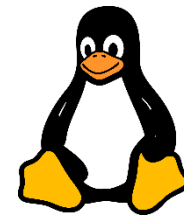
Kite People

Usage in penguin people ecosystem

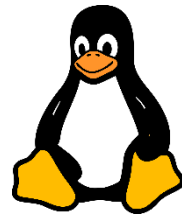


- Tools:
 - dtc - <https://git.kernel.org/pub/scm/utils/dtc/dtc.git/>
 - dt-schema - <https://github.com/devicetree-org/dt-schema/>
- libfdt, dtc is imported from git.kernel.org tree
- Dt-schema checkers are maintained separately.
 - Core bindings are maintained in dt-schema repository
 - Specific bindings maintained in kernel.org Documentation/devicetree/bindings/
- Basic rules:
 - Must be hardware description (in some cases, firmware description is allowed)
 - Shall adhere to device tree bindings (in yaml)
- Unstated rules: quite a few, some of which involves usage by Linux drivers.
- Licensing: GPL2

SoC View from the penguin people

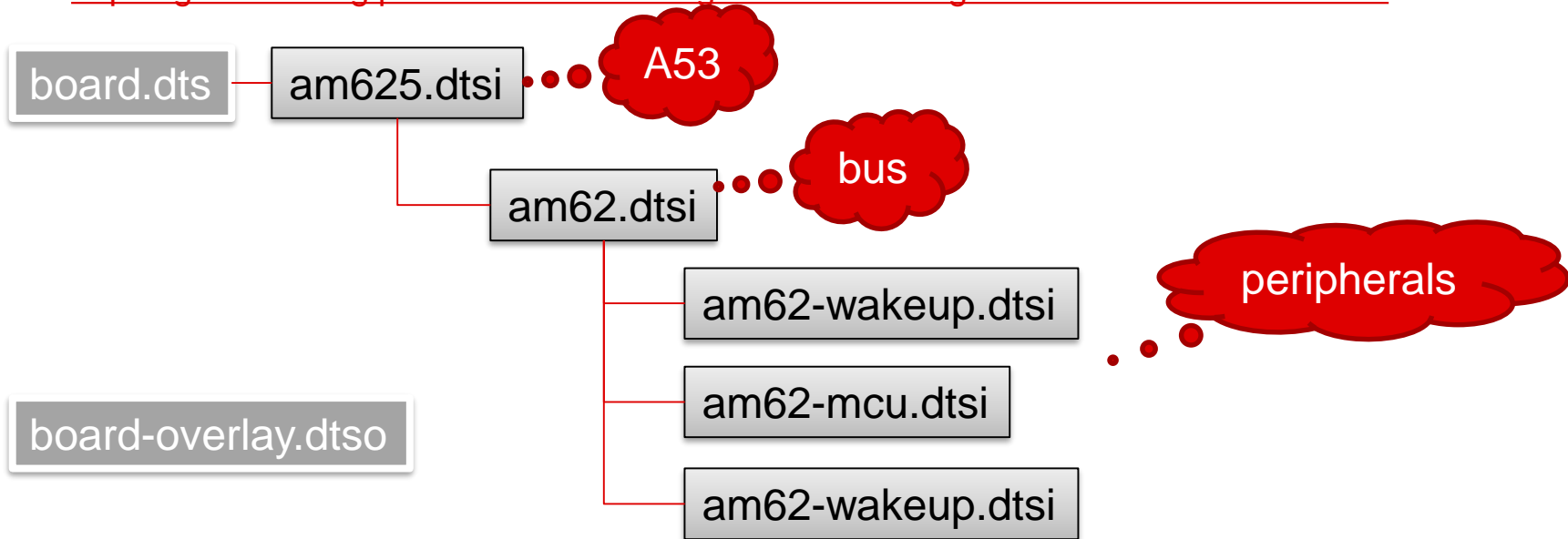


DT View from penguin people



- How does the AM625 device tree structure look like?

- <https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/tree/arch/arm64/boot/dts/ti>

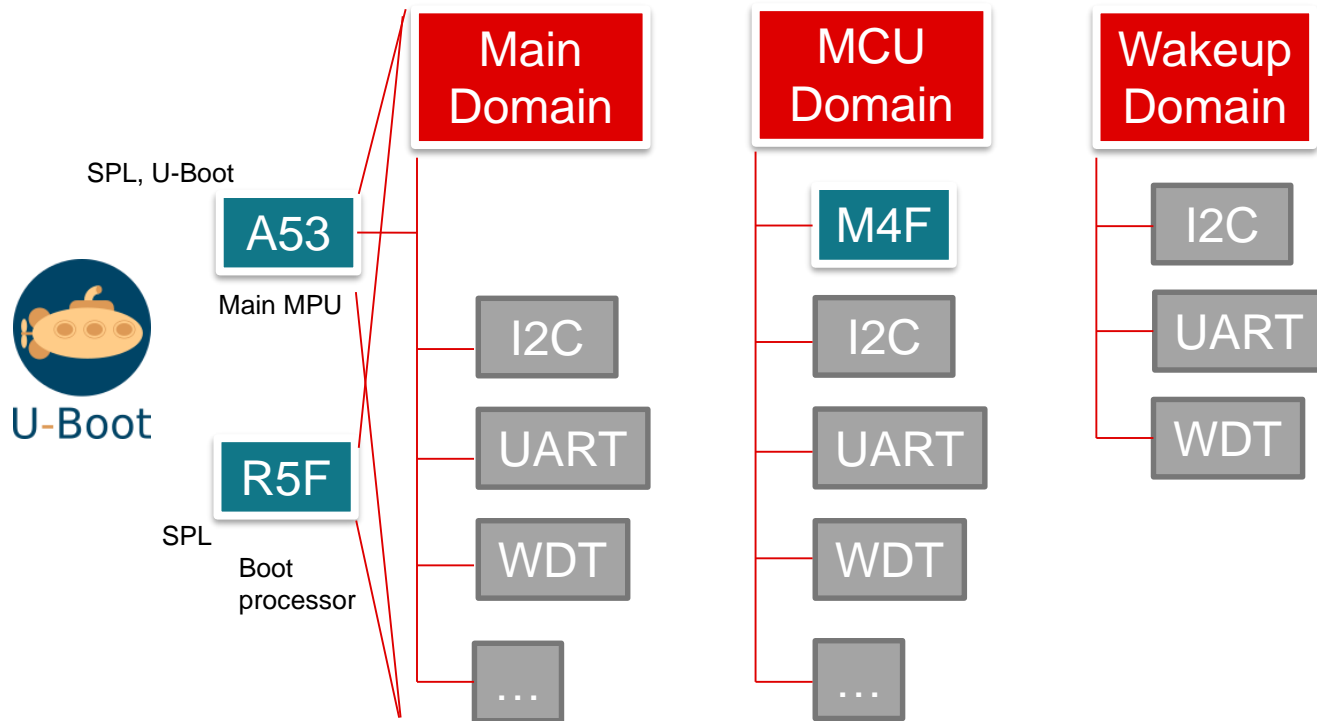


Usage in submarine people ecosystem



- Tools:
 - libfdt, dtc - <https://git.kernel.org/pub/scm/utils/dtc/dtc.git/>
- Tries to stay in sync with kernel.org
- Also has it's own additional bindings (doc/device-tree-bindings/)
 - Bootph binding – now part of dt-schema properties
 - Binman – in discussion, currently U-boot specific
- Very similar to kernel.org (shares the same rules), import devicetree from kernel.org periodically to stay in sync, BUT..
 - Needs a few tweaks
 - Memory constraints
 - Has peripherals supported that kernel doesn't use.
- Licensing: GPL2+

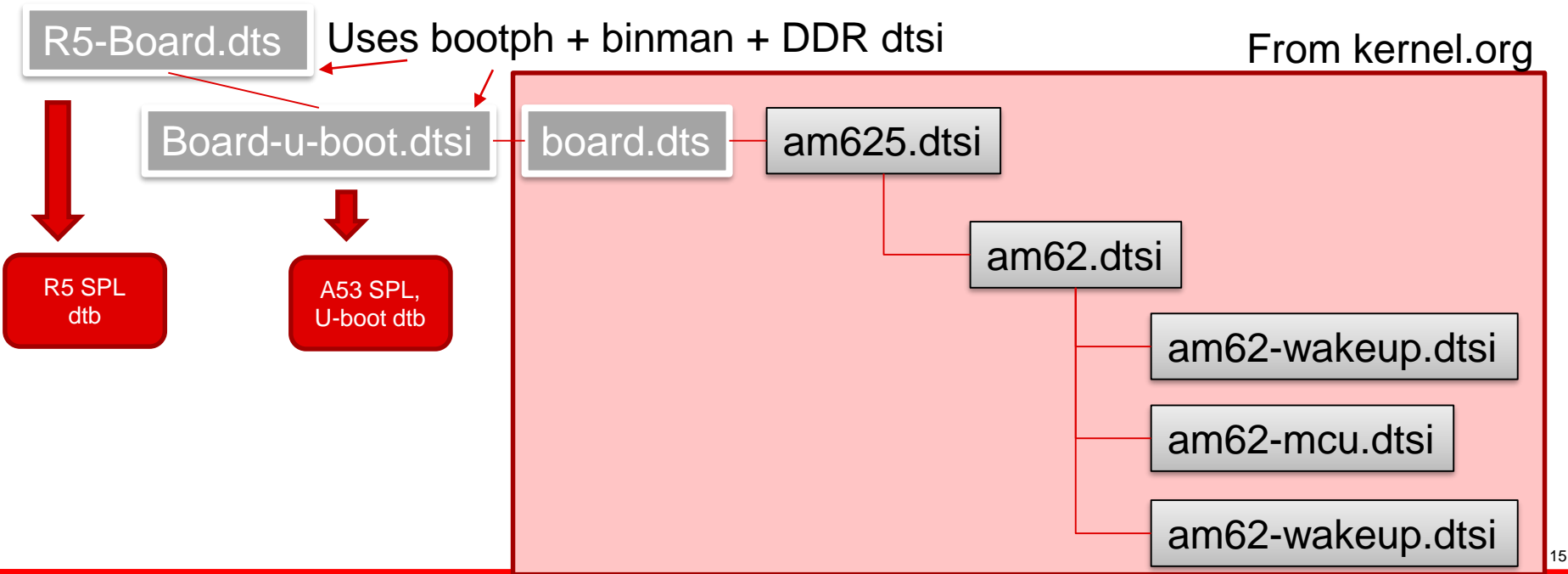
SoC View from the submarine people



DT View from submarine people



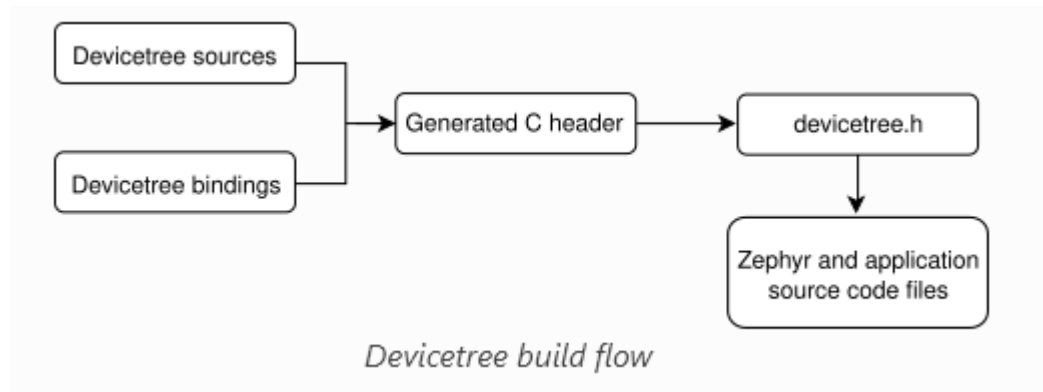
- How does the AM625 device tree structure look like?
 - <https://source.denx.de/u-boot/u-boot/-/tree/master/arch/arm/dts>



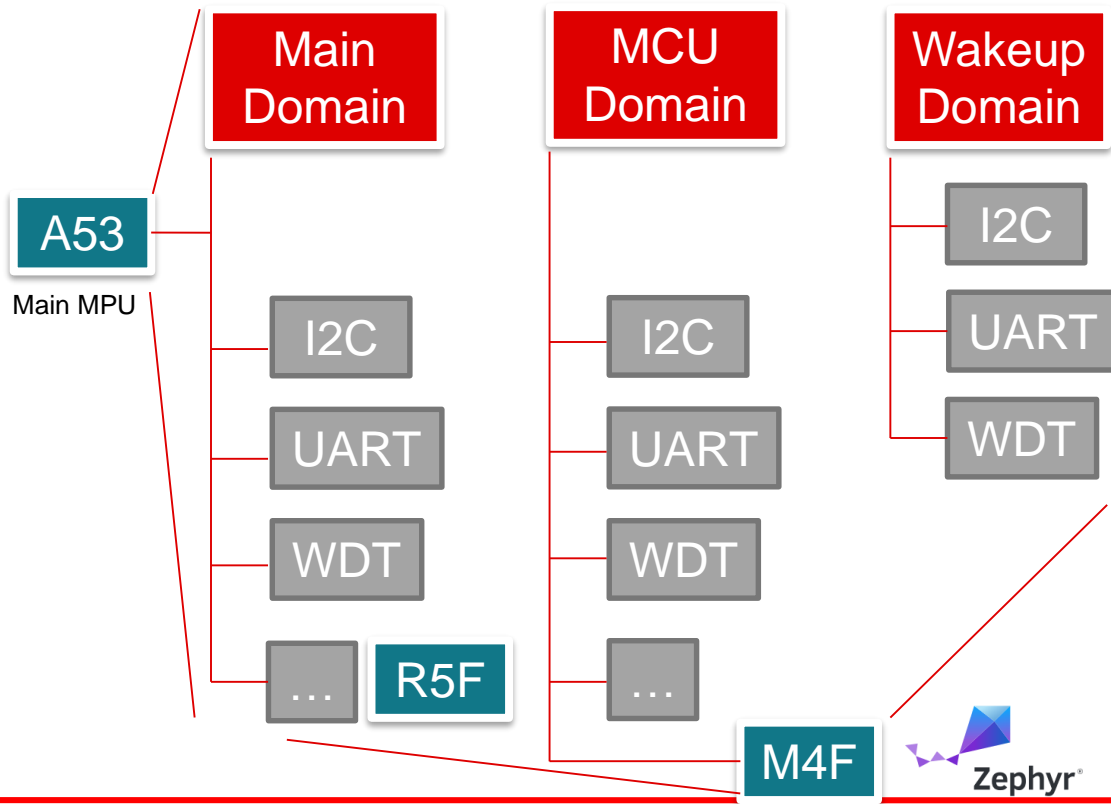
Usage in kite people ecosystem



- Source: <https://github.com/zephyrproject-rtos/zephyr/tree/main/dts/bindings/>
- Has it's own [bindings and device tree model](#).
- Uses C headers as actual link to Zephyr.
- Mix of Native drivers and HAL drivers
- Resource constraints, runtime overheads (See <https://www.youtube.com/watch?v=w8GgP3h0M8M>)
- Licensing: Apache-2.0



SoC View from the kite people



DT View from kite people



- How does the AM625 device tree structure look like?
- <https://github.com/zephyrproject-rtos/zephyr/tree/main/dts/arm/ti>
<https://github.com/zephyrproject-rtos/zephyr/tree/main/dts/arm64/ti>

boards/arm64/am62x_a53/phycore_am62x_a53.dts

boards/arm/am62x_m4/am62x_m4_sk.dts

dts/arm64/ti/ti_am62x_a53.dtsi

dts/arm/ti/am62x_m4.dtsi

<https://docs.zephyrproject.org/latest/build/dts/troubleshooting.html> is your friend!



And... other people

- Jailhouse <https://github.com/siemens/jailhouse/tree/master/configs/arm64/dts>
- Xen
- Trusted Firmware Cortex-A ...



By Hans Bol - <http://balat.kikirpa.be/object/119881>, Public Domain,
<https://commons.wikimedia.org/w/index.php?curid=51006153>

Likes

- Linux Kernel
 - Bindings are strict
 - Definitions of what can and cannot be integrated is clear
- U-Boot
 - Integration is clean
 - Language remains “same-ish” as kernel
- Zephyr
 - Focus on resource and performance

Dis-Likes

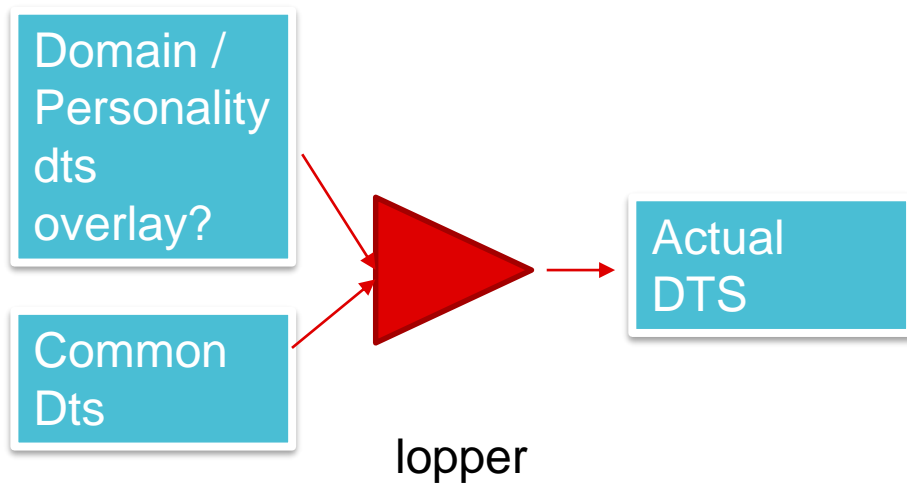
- Linux Kernel
 - Flexibility
 - Performance and Bloat (-EPROBEDEFER?)
- U-Boot
 - Still feels like a bunch of band-aids
- Zephyr
 - Device-tree language is the only common part with the rest of the ecosystem.
 - The actual dts, in reality, looks nothing like U-Boot or Linux Kernel

Solution? Middle Ground?

- System Device tree and Lopper? <https://github.com/devicetree-org/lopper>
- <https://static.linaro.org/connect/san19/presentations/san19-115.pdf>



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Impediments

- Are we willing to adopt lopper in various s/w ecosystems?
- DT Licensing? GPL-2 Vs GPL-2+ Vs Apache-2 ... (and others)
 - Solution might be dual or multiple licensing
- What will be canonical source for DT, domain hints and bindings?
 - Will kernel maintainers be willing to host DT, domain hints and bindings not belonging to kernel?
 - Can dt and bindings move out of kernel tree? (hasn't so far)..<
- Can lopper be integrated into all the s/w flows? (zephyr has potential, U-boot, kernel?)

Benefits

- Consolidated tooling
- DT itself is hard for new users. But, users shouldn't need to learn new DT details based on which OS they are on.
- “Universal DT” OR putting “DT in ROM” is not what I expect any time in near future, but hoping to see lesser chaos.

Credits and Acknowledgement

- Texas Instruments Inc.
- The Linux Foundation.
- Linaro and OpenAMP members
- Vaishnav Achat, Christopher Friedt, Arnaud Pouliquen, Bill Mills, Tom Rini, Krzysztof Kozlowski, Rob Herring, and so many more..

Q&A

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- BeagleBoard.org discord (#beagleplay channel) <https://discord.gg/nUQjwnyw>

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