Devicetree BOF

ELCE 2018
Edinburgh, UK

Frank Rowand, Sony
My Goal

Do NOT show all of the slides
Agenda

- Collect questions, areas of interest
- Past events
- Future events
- New since elc 2017
- dtc compiler update
- Overlay update
- questions, comments, issues, concerns from the crowd
What do you want to talk about?

questions

comments

issues

concerns
Plumbers 2017 Summary

September 2017
Los Angeles

Was not scheduled
-- not enough interest / commitment
Devicetree Workshop Oct 2017
Prague, Czech Republic

https://elinux.org/Device_tree_future
#Kernel_Summit_2017.2C_Devicetree_Workshop

- slides
- notes

Main topic areas:

=== Validation Tools & Schema
=== Runtime usage
=== DTS maintenance issues
=== More stuff
Devicetree Workshop 2017

9:30 Welcome and Schedule bashing
9:40 Encoding and Schema checking: Framing the problem
9:45 DT YAML encoding overview
10:00 YAML encoding discussion
10:20 DT Schema format - option 1
10:35 DT Schema format - option 2
10:50 DT Schema discussion - what should go in the spec?
11:50 Code Generation from DT
12:10 Runtime memory consumption
14:30 Overlay maintenance plan
14:45 Avoiding duplicate descriptions
15:00 Criteria for accepting board files
15:15 Location for maintaining bindings - how to handle foreign bindings
15:30 Sharing Generic bindings
15:45 ABI Stability
16:00 [break and overflow discussion]
16:30 DT health check
16:50 devicetree.org update
17:05 EBBR Discussion
17:20 Closing and feedback
Plumbers 2018

November 13 - 15, 2018
Tuesday - Thursday
Vancouver, British Columbia, Canada

co-located with the Linux Kernel Summit

Plumbers session:
Wednesday 14 November, morning
Devicetree Specification

(old news...)

Devicetree Specification 0.1 supersedes ePAPR for the Linux kernel, continues to evolve

https://www.devicetree.org/specifications/

Mail list, Build Instructions, etc

https://www.devicetree.org/collaborate/

Repository

https://github.com/devicetree-org/devicetree-specification
dtc Compiler
dtc Compiler

- YAML encoded output format
  * for validation tools
- New library: pylibfdt
- Ability to make nodes conditional on them being referenced
  * Size reduction
- Overlay syntactic sugar
  * Eliminate hard coding overlay metadata
- Fdtoverlay
  * Standalone tool to apply overlay(s)
dtc - Devicetree Build Checks

Rob has been enhancing dtc error checks

Enabled for “W=1” builds

$ make V=0 W=1 qcom-apq8074-dragonboard.dtb

make[1]: Entering directory `/local/frowand_nobackup/src/git_linus/build/dragon_linus_4.10'
    DTC arch/arm/boot/dts/qcom-apq8074-dragonboard.dtb
Warning (unit_address_vs_reg): Node /memory has a reg or ranges property, but no unit name
Warning (unit_address_vs_reg): Node /soc/spmi@fc4cf000/pm8941@0/vadc@3100/die_temp has a reg or ranges property, but no unit name
Warning (unit_address_vs_reg): Node /soc/spmi@fc4cf000/pm8941@0/vadc@3100/ref_625mv has a reg or ranges property, but no unit name
Warning (unit_address_vs_reg): Node /soc/spmi@fc4cf000/pm8941@0/vadc@3100/ref_1250v has a reg or ranges property, but no unit name
Warning (unit_address_vs_reg): Node /soc/spmi@fc4cf000/pm8941@0/vadc@3100/ref_gnd has a reg or ranges property, but no unit name
Warning (unit_address_vs_reg): Node /soc/spmi@fc4cf000/pm8941@0/vadc@3100/ref_vdd has a reg or ranges property, but no unit name
make[1]: Leaving directory `/local/frowand_nobackup/src/git_linus/build/dragon_linus_4.10'
dtc - Devicetree Build Checks

commits from February 10, 2017 to date in dtc repo

add SPI bus checks
add I2C bus checks
drop warning for missing PCI bridge bus-range
add graph binding checks
add a check for duplicate unit-addresses of child nodes
add chosen node checks
add aliases node checks
check for #{size,address}-cells without child nodes
add string list check for *-names properties
add string list check
add a string check for 'label' property
add interrupts property check
add gpio binding properties check
add phandle with arg property checks
Warn on node name unit-addresses with '0x' or leading 0s
Add bus checks for simple-bus buses
Add bus checks for PCI buses
Add Warning for stricter node name character checking
Add Warning for stricter property name character checking
Overlay
Overlay

- U-Boot overlay support
  - enhancements have been added

Alternative to Linux kernel overlay loader for some use cases
overlay validation - Linux kernel

Patches under review on mail list, not yet accepted to main line - may change

[PATCH v4 00/18] of: overlay: validation checks, subsequent fixes
Mon, 15 Oct 2018 19:37:20 -0700
https://lore.kernel.org/lkml/
1539657458-24401-1-git-send-email-frowand.list@gmail.com/T/#u

Overlay loader remains out of tree, so validation will only be visible for unittest, FPGAs, or if you use the out of tree overlay loader

Exposed errors in core devicetree code
Fixes are in the patch series
WARNING: memory leak will occur if overlay removed, property: <prop_path>  
   cause: property add or modify in node not created by an overlay

ERROR: memory leak before free overlay changeset, <node_path>  
   cause: too many of_node_put()

ERROR: memory leak, expected refcount 1 instead of <refcount>,  
   of_node_get()/of_node_put() unbalanced - destroy cset entry: attach overlay node <node_path>  
   cause: too many of_node_get() or not enough of_node_put()
validation - ERROR

Malformed FDT will not cleanly apply

ERROR: changing value of #address-cells is not allowed in <node_path>

ERROR: changing value of #size-cells is not allowed in <node_path>

ERROR: multiple fragments add and/or delete node <node_path>

ERROR: multiple fragments add, update, and/or delete property <prop_path>
ERROR: multiple fragments add and/or delete node <node_path>

# drivers/of/unittest-data/overlay_bad_add_dup_node.dts:

// SPDX-License-Identifier: GPL-2.0
/dts-v1/;
/plugin/;

/*.*/
  * &electric_1/motor-1 and &spin_ctrl_1 are the same node:
  *   /testcase-data-2/substation@100/motor-1
  *
  * Thus the new node "controller" in each fragment will
  * result in an attempt to add the same node twice.
  * This will result in an error and the overlay apply
  * will fail.
  */

&electric_1 {
    motor-1 {
        controller {
            power_bus = < 0x1 0x2 >;
        }
    }
};

&spin_ctrl_1 {
    controller {
        power_bus_emergency = < 0x101 0x102 >;
    }
};
ERROR: multiple fragments add, update, and/or delete property <prop_path>

# drivers/of/unittest-data/overlay_bad_add_dup_prop.dts:

// SPDX-License-Identifier: GPL-2.0
/dts-v1/;
/plugin/;

/*
 * &electric_1/motor-1 and &spin_ctrl_1 are the same node:
 * /testcase-data-2/substation@100/motor-1
 *
 * Thus the property "rpm_avail" in each fragment will
 * result in an attempt to update the same property twice.
 * This will result in an error and the overlay apply
 * will fail.
 */

&electric_1 {
    motor-1 {
        rpm_avail = < 100 >;
    }
};

&spin_ctrl_1 {
    rpm_avail = < 100 200 >;
};
Linux Internal ERROR

ERROR: of_node_release(), unexpected properties in <node_path>
Metadata

How should the metadata required by overlays be encoded in the FDT?

Discussion was in progress on devicetree-compiler list

Subject: [RFC] devicetree: new FDT format version
Message-ID: <b96829f9-2e8b-fdc5-5090-58591e2260cf@gmail.com>
Date: Mon, 22 Jan 2018 00:09:18 -0800

side-effect: update of FDT format required
Metadata

Motivation:
- size reduction of FDT and kernel data
- remove metadata from tree name space

side-effects:
- update of FDT format required
- additional features possible, eg
  * phandle as property value decompile
  * validation features
Metadata - base FDT overhead

Metadata overhead measured for arch/arm/boot/dts/*

“symbols old fmt” is added size from 'dtc -@'
for the current FDT format

“symbols new fmt” is added size from 'dtc -@'
for first proposed format in the email thread
FDT size, sort on: new format symbols
symbols old fmt, symbols new fmt
FDT size, sort on: saved
old fmt, new fmt, no symbols, saved
## Metadata - base FDT overhead

Metadata overhead measured for arch/arm/boot/dts/*

<table>
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<tr>
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<th>delta symbols</th>
<th>delta new fmt</th>
<th>bytes saved</th>
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<tr>
<td>0%</td>
<td>1220</td>
<td>68</td>
<td>149</td>
<td>-81</td>
</tr>
</tbody>
</table>

- "delta symbols" is added size from 'dtc -@'
- "new fmt" is added size from 'dtc -@' for first proposed in the email thread
dtc creates the .dtb OVERLAY INTERNAL DATA ("metadata")

Do not hand code overlay internal data nodes in DTS source:

fragment@
  __overlay__
  __fixup__
  __local_fixup__
  __symbols__
/dts-v1/;
/plugin/;
/
{
    fragment@0 {
        target-path = "/soc/base_fpga_region";
        #address-cells = <1>;
        #size-cells = <1>;

        __overlay__ {
            ranges = <0x00000000 0x00000000 0xc0000000 0x00040000>,
                     <0x00000001 0x00000000 0xff200000 0x00001000>;

            external-fpga-config;

            #address-cells = <2>;
            #size-cells = <1>;

            fpga_pr_region0 {
                compatible = "fpga-region"
                fpga-bridges = <&freeze_controller_0>;
                ranges;
            };

            freeze_controller_0: freeze_controller@100000450 {
                compatible = "altr,freeze-bridge-controller";
                reg = <0x00000001 0x00000450 0x00000100>;
                interrupt-parent = <&intc>;
                interrupts = <0 21 4>;
            };
        }
    }
};
dtc - overlays - example - new.dts

/dts-v1/;
/plugin/;

&fpga_region {
  ranges = <0x00000000 0x00000000 0xc0000000 0x00004000>,
          <0x00000001 0x00000000 0xff200000 0x00001000>;
  external-fpga-config;
  #address-cells = <2>;
  #size-cells = <1>;

  fpga_pr_region0 {
    compatible = "fpga-region";
    fpga-bridges = <&freeze_controller_0>;
    ranges;
  }

  freeze_controller_0: freeze_controller@100000450 {
    compatible = "altr,freeze-bridge-controller";
    reg = <0x00000001 0x000000450 0x00000010>;
    interrupt-parent = <&intc>;
    interrupts = <0 21 4>;
  }
};
dtc - overlays - example

```bash
$ diff -b -u old.dts new.dts
--- old.dts
+++ new.dts
@@ -1,13 +1,7 @@
 /dts-v1/;
 /plugin/;

-/ {      
-   fragment@0 {
-       target-path = "/soc/base_fpga_region";
-       #address-cells = <1>;
-       #size-cells = <1>;
-       __overlay__ {
-            &fpga_region {
ranges = <0x00000000 0x00000000 0xc0000000 0x00040000>,
             <0x00000001 0x00000000 0xff200000 0x00001000>;

@@ -28,6 +22,4 @@
            interrupt-parent = <&intc>;
            interrupts = <0 21 4>;
        }

-    }
-};
-}
};
```
What if there is no label for the overlay target in the base devicetree?

What if the overlay target is the root node (dtc does not allow a label on the root node)?
/dts-v1/;
/plugin/;

&{/soc/base_fpga_region} {
    ranges = <0x00000000 0x00000000 0xc0000000 0x00040000>,
           <0x00000001 0x00000000 0xff200000 0x00001000>;

    external-fpga-config;

    #address-cells = <2>;
    #size-cells = <1>;

    fpga_pr_region0 {
        compatible = "fpga-region";
        fpga-bridges = <&freeze_controller_0>;
        ranges;
    }

    freeze_controller_0: freeze_controller@100000450 {
        compatible = "altr_freeze_bridge_controller";
        reg = <0x00000001 0x000000450 0x00000010>;
        interrupt-parent = <&intc>;
        interrupts = <0 21 4>;
    }
};
next expected format change

Explicit connector node
.dtsi source vs overlay .dtsi

(More slides available after the 'END' slide)
Overlays

https://elinux.org/Frank%27s_Evolving_Overlay_Thoughts
What do you want to talk about?

questions

comments

issues

concerns
How to get a copy of the slides

1) frank.rowand@sony.com

2) http://elinux.org/Device_Tree

3) http://events.linuxfoundation.org
THE END

Thank you for your participation...
.dtsi source vs overlay .dtsi

With the new dtc --

Overlay .dts file contains directives:

/dts-v1/;
/plugin/;

.dtsi include file does not
Use include as .dtsi or overlay

With sugar syntax, the syntax used by an overlay is now compatible with the syntax used by an include file, if the include file uses labels as paths instead of using explicit paths.

- This may be convenient for development workflows

- Do not become dependent on this for overlays that will be long lived -- current thinking is that we want many / most overlays to use the connector model
Use include as .dtsi or overlay

---------- base tree ------------------------------

$ expand fpga_tree.dts
/dts-v1/;

/* labels used by overlay are in the base tree */

/ {
    soc {
        intc: interrupt_ctrl {
        }
        fpga_region: base_fpga_region {
        }
    }
};

/include/ "fpga_plugin_or_dtsi.dts"

---------- overlay ---------------------------------

$ expand fpga_overlay.dts
/dts-v1/;
/plugin/;

/include/ "fpga_plugin_or_dtsi.dts"
The .dtsi

$ expand fpga_plugin_or_dtsi.dts
&fpga_region {
  ranges = <0x00000000 0x00000000 0xc0000000 0x00040000>,
           <0x00000001 0x00000000 0xff200000 0x00001000>;

  external-fpga-config;

#address-cells = <2>;
#size-cells = <1>;

fpga_pr_region0 {
  compatible = "fpga-region";
  fpga-bridges = <&freeze_controller_0>;
  ranges;
};

freeze_controller_0: freeze_controller@10000450 {
  compatible = "altr,freeze-bridge-controller";
  reg = <0x00000001 0x00000450 0x00000100>;
  interrupt-parent = <&intc>;
  interrupts = <0 21 4>;
};
Kernel Configuration Info -- OLD

In tree

```
scripts/dtc/dt_to_config
   arch/arm/boot/dts/qcom-apq8074-dragonboard.dts
   --short-name
   --config ${KBUILD_OUTPUT}/.config
   --config-format
   > dragon_config_info

$ grep -i coincell dragon_config_info

# -d-c-----n--F : coincell@2800 : qcom,pm8941-coincell : drivers/misc/qcom-coincell.c : CONFIG_QCOM_COINCELL : n
# CONFIG_QCOM_COINCELL is not set
# CONFIG_QCOM_COINCELL=y

# -d-c-----n--F : coincell@2800 : qcom,pm8941-coincell : ..... 
# CONFIG_QCOM_COINCELL is not set
# CONFIG_QCOM_COINCELL=y
```
Debug Tools - OLD - update

dtc: dts source location annotation
    - Provide source locations from .dts & .dtsi
    - Several proof of concept versions on devicetree-compiler list, up to October 2015
    - Stalled, awaiting some of Frank's bandwidth

Project picked up by Julia Lawall

To: devicetree-compiler@vger.kernel.org
Subject: [PATCH 1/3 v4] annotations: check for NULL position
Date: Fri, 2 Feb 2018 21:41:48 +0100
source location annotation (old)

----- short format -----

sdhci@f9824900 { /* qcom-apq8074-dragonboard.dts:14 */
    compatible = "qcom,sdhci-msm-v4"; /* qcom-msm8974.dtsi:240 */
    reg = <0xf9824900 0x11c 0xf9824000 0x800>; /* qcom-msm8974.dtsi:241 */
    reg-names = "hc_mem", "core_mem"; /* qcom-msm8974.dtsi:242 */
    interrupts = <0x0 0x7b 0x0 0x0 0x8a 0x0>; /* qcom-msm8974.dtsi:243 */
    interrupt-names = "hc_irq", "pwr_irq"; /* qcom-msm8974.dtsi:244 */
    clocks = <0xd 0xd8 0xd 0xd7>; /* qcom-msm8974.dtsi:245 */
    clock-names = "core", "iface"; /* qcom-msm8974.dtsi:246 */
    status = "ok"; /* qcom-apq8074-dragonboard.dts:17 */
    bus-width = <0x8>; /* qcom-apq8074-dragonboard.dts:15 */
    non-removable; /* qcom-apq8074-dragonboard.dts:16 */
}; /* qcom-apq8074-dragonboard.dts:18 */
Debug Tools -- semi-OLD

scripts/dtc/dt_prop
- Compare properties accessed on target system vs a device tree (dtX)
- available on elinux.org
- Plan to submit to mail list “any day now”

==> Stalled, awaiting some of Frank's bandwidth
dt_prop example snippets

$ dt_prop --td dmesg_4.5-rc5_160307_2100 qcom-apq8074-dragonboard.dts

# --- dmesg_4.5-rc5_160307_2100
# +++ qcom-apq8074-dragonboard.dts
/dts-v1/;

//! ***** i2c@f9964000 disabled *****
i2c@f9964000 {
  + #address-cells;
  + #size-cells;
  + clock-names;
  + clocks;
  compatible;
  + interrupts;
  + reg;
  status;
};
Debug Tools - OLD

dt_node_info, dt_stat

- Aids boot (or module load) debugging
- Status of device creation, devicetree nodes, driver discovery, driver binding
- proof of concept on elinux.org
- Stalled, awaiting some of Frank's bandwidth
dt_node_info example 1

$ dt_node_info coincell
===== devices

===== nodes
/soc/spmi@fc4cf000/pm8941@0/qcom,coincell@2800 qcom,

===== nodes bound to a driver

===== nodes with a device

===== nodes not bound to a driver
/soc/spmi@fc4cf000/pm8941@0/qcom,coincell@2800 qcom,

===== nodes without a device
/soc/spmi@fc4cf000/pm8941@0/qcom,coincell@2800 qcom,
dt_node_info example 2

$ dt_node_info coincell

===== devices
/sys/devices/platform/soc/fc4cf000.spmi/spmi-0/0-00/

===== nodes
/soc/spmi@fc4cf000/pm8941@0/qcom,coincell@2800 qcom,

===== nodes bound to a driver

===== nodes with a device
/soc/spmi@fc4cf000/pm8941@0/qcom,coincell@2800 qcom,

===== nodes not bound to a driver
/soc/spmi@fc4cf000/pm8941@0/qcom,coincell@2800 qcom,

===== nodes without a device
Overlays  -- more stuff...
Overlays - some use cases

- Expansion slots / external connectors
  - beaglebone
  - raspberry pi
  - minnowboard
  - C.H.I.P.
  - Arduino
  - seeedstudios Grove 4 pin connectors
  - others?

- FPGA
Overlays - some use cases

- Combinatorial explosion of .dts / .dtb files

  example:
  Devicetree Hardware Autoconfiguration
  Hans de Goede
  ELC Europe 2016
Overlays, one of the gating factors

On 10/18/17 14:46, Frank Rowand wrote:

> On Wed, 2017-10-18 at 10:44 -0500, Rob Herring wrote:

>> The issue remains that the kernel is not really setup to deal with any
>> random property or node to be changed at any point in run-time. I
>> think there needs to be some restrictions around what the overlays can
>> touch. We can't have it be wide open and then lock things down later
>> and break users.

> That paragraph is key to any discussion of accepting code to apply overlays.
> Solving that issue has been stated to be a gating factor for such code from
> the beginning of overlay development.

(Not the only remaining issue.)
Overlays, Linux kernel progress

(Not a complete list)

- overlay.c refactored
- resolver.c refactored
- hand coded overlays in devicetree source files
  - resolved by sugar syntax if base tree has required labels
  - continued dtc enhancements underway
- papered over issue: free FDT or expanded devicetree while pointers into them still exist
- unable to free overlay FDT and overlay expanded device tree after overlay removal (memory leak)
- FDT format update up in the air
- of locking architecturally broken
- pre-removal checks needs to ensure relevent driver(s) unbind
- connectors architecture up in the air
- overlay semantics not fully specified
- overlay manager (do not accept until gating requirements are resolved)
Devicetree Development History

Some random statistics
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v4.10.. top drivers/of/ commits
(February 19, 2017 ..)

What have patch topics been?

Very imprecise topic count (do not take the list too seriously...)

Based mostly on leading fields of patch subject
v4.10.. top drivers/of/ commits
(loosely based by patch comment tag)

23 overlay
10 device property
12 test
  7 of_mdio
  7 irq
  6 fdt
  6 of_graph
  6 device
  5 pci
  4 platform
  3 base
Resources

http://elinux.org/Device_Tree_presentations_papers_articles
http://elinux.org/Device_Tree_presentations_papers_articles#debug

http://elinux.org/Device_Tree_Reference
Resources

Devicetree Documentation

elinux.org/Device_Tree_Reference

- becoming more complete
- contributions and comments welcome
Resources

dtx_diff
dtc --annotate
dt_node_info

Solving Device Tree Issues:
Frank Rowand, elce 2015
(In this presentation, dtx_diff was named dtdiff.)

Supporting material for: Solving Device Tree Issues:
http://elinux.org/Device_Tree_frowand
section: Embedded Linux Conference Europe (ELCE) - October 6, 2015

dt_to_config

Solving Device Tree Issues - Part 2:
Frank Rowand, LinuxCon Japan 2016
http://elinux.org/images/5/50/Dt_debugging_part_2.pdf
Resources

dt_prop

Solving Device Tree Issues - Part 3:
Frank Rowand, elce 2016

Supporting material for: Solving Device Tree Issues - Part 3:
kernel patches
scripts/dtc/dts_diff
scripts/dtc/dt_prop
http://elinux.org/Device_Tree_frowand
  section: Resources for "Solving Device Tree Issues - Part 3" talk