Devicetree BOF

Open Source Summit Japan 2018
Tokyo

Frank Rowand, Sony
My Goal

Do NOT show all of the slides
Agenda

- Past events
- Future events
- New since elc 2017 (February 2017)
- Tools status
- dtc compiler
- questions, comments, issues, concerns from the crowd
- commit statistics
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

=== 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
https://www.linuxplumbersconf.org/event/2/overview

colocated with the Linux Kernel Summit

Devicetree track proposal submitted

Email me any topics you want added to the schedule (or talk to me here)
(Linaro) EBBR Specification

Embedded Base Boot Requirements

Document basic requirements on firmware to implement a standard boot path on embedded boards

Expect primary users to be embedded & developer Arm boards using U-Boot firmware and Devicetree machine description

Details:

(most of this email shown after the next slide)
(Linaro) EBBR Specification

Mail List
subscribe: https://lists.linaro.org/mailman/listinfo/boot-architecture
archive: https://lists.linaro.org/pipermail/boot-architecture/
(EBBR emails start April 2018)

Repository
https://github.com/ARM-software/ebbr
Linaro Connect Hong Kong 2018

Attendees:
Alexander Graf (SuSE)
Grant Likely (Arm)
Bill Mills (TI)
Peter Robinson (Red Hat/Fedora)
Dong Wei (Arm)
Yang Zhang (Linaro/96Boards)

Notes

- We discussed the purpose & intent of EBBR
  - Is intended to document the basic requirements on firmware to implement a 'standard' boot path on embedded boards.
  - Needed by distros (Fedora, SuSE, Debian, etc) to support boards out of the box
  - Needed by OpenEmbedded, Yocto, etc to get away from custom platform specific hacks
  - Establishes a foundation for implementing SecureBoot, A/B updates, and other useful boot scenarios in a consistent way.
- We expect the primary users of EBBR will be embedded & developer Arm boards using U-Boot firmware and Devicetree machine description
- We expect a distribution will be able to use the same software (Distro Installer, Grub, Linux UEFI stub, Shim), and the same media (installer images) on both embedded and server platforms
- We discussed what EBBR should contain
  - Will document interfaces and standards; not specific projects
  - Will specify a subset of the UEFI specification.
    - Boot services are in
    - Runtime services can be implemented with empty stubs
    - Need to work out what to do with runtime setting of variables
  - For the first release ("EBBR level 0"), it will track features available in upstream
    - In concrete terms this means EBBR can be implemented with upstream U-Boot or Tianocore.
    - Subsequent releases will refine the requirements as needed and as software improves

- Expected target audience
  - embedded board vendors - Gives strong guidance on how to make a widely supported board
  - Linux distributions - Can make EBBR compliance a requirement for support
  - End users - EBBR will make it simpler to use embedded Arm boards because each board will not require special setup instructions or image formats
- Roadmap
  - 96Boards wants to specify EBBR compliance in an upcoming spec to be announced at Linaro Connect in the fall (about 6 months time)
  - Need to have general agreement on the content of EBBR well before that (2-3 months?)
  - Need to have a final EBBR 1.0 release before the 96Boards spec announcement
- Work items:
  - Transcode existing EBBR draft into text markup and check into Git repo
  - Review current EBBR draft and compare with available U-Boot functionality
    - Identify changes required to EBBR spec
    - Identify gaps in U-Boot functionality that can reasonably be addressed in the EBBR v1.0 timeframe
  - Draft roadmap of goals - particularly focusing on functionality required by Linux distributions
  - Stand up issue tracker (GitHub?)
Open Questions:

- Can the EBBR document be drafted in public? (Dong to follow up internally at Arm)
- Where do the Engineering resources come from to make EBBR a reality
  - General call for engineering effort to be committed by interested parties
- Can we use a cut-down LuvOS or UEFI SCT as a specification conformance test suite?

Actions:

- Dong to have Arm internal discussion about moving EBBR draft process onto GitHub or similar
- Markup candidate: Sphinx-doc with reStructuredText markup
- Grant to organize a regular weekly meeting to track EBBR drafting process
  - Make sure to include Tom Rini and Ard Biesheuvel
- Yang to socialize with 96Boards partners to prepare them for EBBR compliance
- (Unassigned) Create a hosting page with issue tracker for EBBR -- TBD after Dong finishes internal due diligence on moving EBBR drafting to a public repository
  - Probably GitHub
Devicetree Specification

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
Tools
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
dtc Compiler
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 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
dtc - overlays - Linux v4.15

dtc creates the .dtb OVERLAY INTERNAL DATA ("metadata")

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

```plaintext
fragment@
  __overlay__
  __fixup__
  __local_fixup__
  __symbols__
```
Metadata

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

Discussion 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
## Metadata - base FDT overhead

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

<table>
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<tr>
<th>row %</th>
<th>dtb no</th>
<th>delta symbols</th>
<th>delta symbols</th>
<th>delta new fmt</th>
<th>bytes saved</th>
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<td>90531</td>
<td>42721</td>
<td>15766</td>
<td>26955</td>
<td></td>
</tr>
<tr>
<td>83%</td>
<td>44302</td>
<td>14582</td>
<td>5163</td>
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<td>66%</td>
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<td>21047</td>
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<td>12864</td>
<td>4305</td>
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<td>1520</td>
<td>1409</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>1220</td>
<td>68</td>
<td>149</td>
<td>-81</td>
<td></td>
</tr>
</tbody>
</table>

- “**delta symbols**” is added size from *'dtc -@'*
- “**new fmt**” is added size from *'dtc -@'* for first proposal in the thread
/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 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 = <0x00000000 0x00000000 0x00000450 0x00000010>;
    interrupt-parent = <&intc>;
    interrupts = <0 21 4>;
  }
};
```plaintext
$ 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>;
    }
  }
-/ }
```

dtc - overlays - example
dtc - overlays - new.dts - no label?

(1) What if there is no label for the overlay target in the base devicetree?

(2) What if the overlay target is the root node (dtc does not allow a label on the root node)?

Support is in upstream dtc project, but not yet imported into Linux as of v4.17
dtc - overlays - no label? (1)

$ cat path_sugar_abs_path_multi_node.dts

/dts-v1/;
/plugin/;
&{[/node_level_1/node_level_2/] {
    #address-cells = <2>;
    #size-cells = <2>;

    my_node@feb90000 {
        compatible = "vendor,device";
        reg = <0 0xfeb90000 0 0x1c>;

    };}
};

$ dtc -O dts path_sugar_abs_path_multi_node.dts
/dts-v1/;
/
{
    fragment@0 {
        target-path = "/[node_level_1/node_level_2]/";

        __overlay__ {
            #address-cells = <0x2>;
            #size-cells = <0x2>;

            my_node@feb90000 {
                compatible = "vendor,device";
                reg = <0x0 0xfeb90000 0x0 0x1c>;

            }
        }
    }
};
$ cat path_sugar_abs_path_root.dts

/dts-v1/;
/plugin/;
&{/}
{
    #address-cells = <2>;
    #size-cells = <2>;

    my_node@feb90000 {
        compatible = "vendor,device";
        reg = <0 0xfeb90000 0 0x1c>;
    };
};/dts-v1/;

$ dtc -O dts path_sugar_abs_path_root.dts
/dts-v1/;
/
{

    fragment@0 {
        target-path = [2f 00];

        __overlay__ {
            #address-cells = <0x2>;
            #size-cells = <0x2>;

            my_node@feb90000 {
                compatible = "vendor,device";
                reg = <0x0 0xfeb90000 0x0 0x1c>;
            };
        };
    };
};/dts-v1/;
.dtsi source vs overlay .dtsi

(More slides available after the 'END' slide)
What do you want to talk about?

questions

comments

issues

concerns
Devicetree Development History

Some random statistics
v4.2. arch/*/boot/dts/ commits

550  arc
54641  arm
13170  arm64
4  c6x
44  cris
93  h8300
33  metag
2  microblaze
1054  mips
31  nios2
7  openrisc
797  powerpc
25  sh
115  xtensa
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<td>v4.8</td>
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<tr>
<td>v4.9</td>
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<td>v4.10</td>
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<td>2017 02 19</td>
</tr>
<tr>
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<tr>
<td>v4.15</td>
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drivers/of/ commits

v4.2  29
v4.3  16
v4.4  38
v4.5  22
v4.6  29
v4.7  40
v4.8  30
v4.9  24
v4.10 28  2017 02 19
v4.11 19  2017 04 30
v4.12 32
v4.13 36
v4.14 38
v4.15 52
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
THE END

Thank you for your participation...
Questions?
Comments?
.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"
$ expand fpga_plugin_or_dtsi.dts

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

eexternal-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>;
};
};
Overlays -- more stuff...
Overlays

- U-Boot overlay support
  - enhancements have been added
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 -- see “Frank's Evolving Overlay Thoughts”:
https://elinux.org/Frank%27s_Evolving_Overlay_Thoughts
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)
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

**dt**x**_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
How to get a copy of the slides

1) frank.rowand@sony.com
2) http://elinux.org/Device_Tree
3) http://events.linuxfoundation.org