



coreboot
Thermal Management on
Intel-based systems

SPEAKER

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Thermal Management : Need ?

- Variety of systems/devices
 - Client/Edge
 - IOT
 - Servers
 - etc...
- Balance between Power and Performance
 - Best Performance/High Speed
 - Longer battery life/Save Energy
 - Optimal power consumption

Thermal Management : Intel Solution


- DPTF (aka DTT) on X86
 - DPTF : Dynamic Platform Thermal Framework
 - DTT : Dynamic Tuning Technology
 - Thermal components referred as participants
 - CPU, Fan, TSRs (on-board **T**hermal **S**ensor **R**egisters) and Battery charger
 - Types of Cooling Policies
 - Active : Fan based cooling
 - Passive : Control Power i.e. Voltage + Frequency
 - Critical : Prevent the system from getting damaged
 - Can also control battery charge rate
 - Flow :
 - ACPI connection with coreboot, EC and Kernel
 - DPTF relies on an assortment of ACPI tables to provide parameters to the DPTF application


Thermal Management : Inside coreboot


- DPTF Thermal Management code layout
 - Intel SoC specific implementation
 - Intel reference board implementation
 - Google reference board implementation
 - Customer design boards specific code
- Reference files:
 - Static ASL files :

`coreboot / src / soc / intel / common / acpi / dptf /`

 charger.asl

 cpu.asl

 dptf.asl

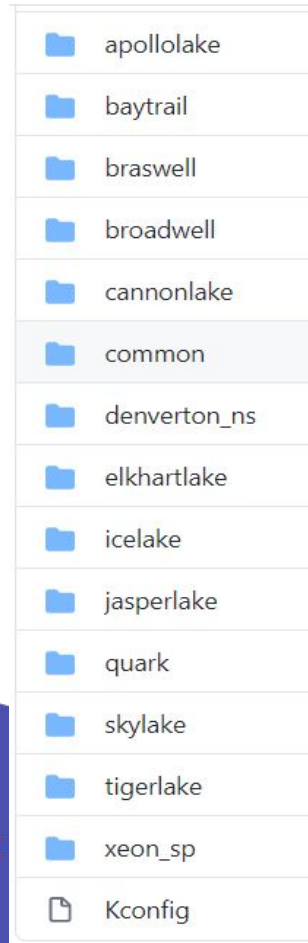
 fan.asl

 thermal.asl

Thermal Management : Inside coreboot

- Intel SoC specific implementation :

`coreboot / src / soc / intel /`



```
braswell/acpi/dptf/thermal.asl  
baytrail/acpi/dptf/thermal.asl  
skylake/acpi/dptf/thermal.asl  
common/acpi/dptf/thermal.asl
```

```
braswell/acpi/dptf/cpu.asl  
baytrail/acpi/dptf/cpu.asl  
skylake/acpi/dptf/cpu.asl  
common/acpi/dptf/cpu.asl
```

```
braswell/acpi/dptf/dptf.asl  
tigerlake/acpi/dptf.asl  
apollolake/acpi/dptf.asl  
baytrail/acpi/dptf/dptf.asl  
skylake/acpi/dptf/dptf.asl  
common/acpi/dptf/dptf.asl
```

```
braswell/acpi/dptf/charger.asl  
baytrail/acpi/dptf/charger.asl  
skylake/acpi/dptf/charger.asl  
common/acpi/dptf/charger.asl
```

```
skylake/acpi/dptf/fan.asl  
common/acpi/dptf/fan.asl
```

Thermal Management : Inside coreboot

- Intel reference board implementation :

apollolake_rvp	harcuvar
baskingridge	icelake_rvp
cannonlake_rvp	jasperlake_rvp
cedaristland_crb	kblrvp
coffeelake_rvp	kunimitsu
d510mo	leafhill
d945gclf	minnow3
dcp847ske	saddlebrook
dg41wv	strago
dg43gt	tglrvp
emeraldlake2	wtm2
galileo	Kconfig
glkrvp	Kconfig.name

coreboot / src / mainboard / intel /

```
wtm2/acpi/thermal.asl  
emeraldlake2/acpi/thermal.asl  
baskingridge/acpi/thermal.asl  
harcuvar/acpi/thermal.asl
```

```
kblrvp/acpi/dptf.asl  
strago/acpi/dptf.asl  
kunimitsu/acpi/dptf.asl  
glkrvp/variants/baseboard/include/baseboard/acpi/dptf.asl  
glkrvp/variants/glkrvp/include/variant/acpi/dptf.asl
```

Thermal Management : Inside coreboot

- Customer boards implementation :

coreboot / src / mainboard / google / hatch / variants /

akemi	kaisa
baseboard	kindred
dooly	kohaku
dratini	mushu
duffy	nightfury
faffy	noibat
hatch	palkia
helios	puff
helios_diskswap	stryke
jinlon	wyvern

```
baseboard/include/baseboard/acpi/dptf.asl  
hatch/include/variant/acpi/dptf.asl  
nightfury/include/variant/acpi/dptf.asl  
palkia/include/variant/acpi/dptf.asl  
helios/include/variant/acpi/dptf.asl  
dratini/include/variant/acpi/dptf.asl  
mushu/include/variant/acpi/dptf.asl  
kindred/include/variant/acpi/dptf.asl  
kohaku/include/variant/acpi/dptf.asl  
jinlon/include/variant/acpi/dptf.asl  
akemi/include/variant/acpi/dptf.asl  
stryke/include/variant/acpi/dptf.asl
```


Thermal Management : DPTF Driver

- SSDT based DPTF policies generation
- Code flow of this new DPTF driver
- How to use the devicetree entries
- Easy enablement and tuning thermal policies

Thermal Management : Policy generation

- Why?
 - Difficult for non-ACPI experts to understand & modify ASL
 - devicetree is the typical way to configure device-specific SSDT entries
- DPTF Policy tables are generated at runtime
 - Typically, runtime data ends up in the SSDT
 - ASL implementation lives in the DSDT
- Reference: [coreboot / src / drivers / intel / dptf /](#)

Thermal Management : DPTF Driver

- Flow
 - sconfig generates .c/.h files at build-time
 - ramstage calls into device drivers to emit AML into the SSDT
 - DPTF driver calls into acpigen library to emit AML bytecode
 - Passed to the OS via coreboot table
 - OS parses DPTF tables, leaves entries in sysfs
 - DPTF application consumes the sysfs entries

Thermal Management: Example

```
device dptf on
chip drivers/intel/dptf
    register "policies.passive[0]" = DPTF_PASSIVE(CPU, TEMP_SENSOR_0, 90, 5000)
device generic 0 on end
end
end
```

- This tells DPTF to poll Temp Sensor 0 every 5 seconds to check if it reaches 90 C
- When it does, it will look to Performance States tables to throttle sources of heat



Thermal Management : Common code

- Advantages:
 - Remove duplicate files and code
 - Easy to manage for non-ACPI experts
 - Less code required to support a new SoC
 - Remove *.asl file dependency
 - Simplify enablement for customer boards

Thermal Management : DPTF Driver

- SSDT based DPTF policies generation
 - Intel Tiger Lake reference board (RVP) implementation
[coreboot / src / mainboard / intel / tglrvp / variants / tglrvp_up3 / devicetree.cb](#)
 - Google Volteer reference board implementation
[coreboot / src / mainboard / google / volteer / variants / baseboard / devicetree.cb](#)
 - Customer specific board override implementation
[coreboot / src / mainboard / google / volteer / variants / voxel / overridetree.cb](#)



Questions?

Thank you