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Beyond Printf – Real-Time UEFI Debugging

UEFI 2021 Virtual Plugfest

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Meet the Presenter

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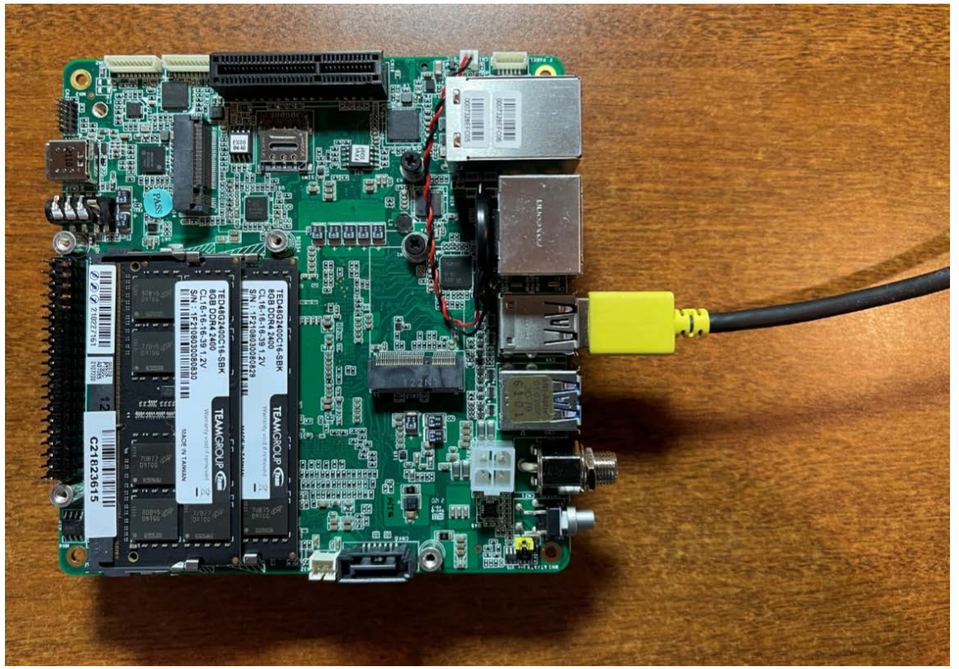
Agenda

- Intel Trace Hub
  - Trace Sources
  - Trace Sinks
- Instruction Trace
- Setting up the Trace Hub
- Setting up At-Speed Printf
- Demo

JTAG Access

- XDP – Open Chassis: “MinnowBoard”

- Direct Connect Interface (DCI) – Closed Chassis: “AAEON UP Xtreme i11”



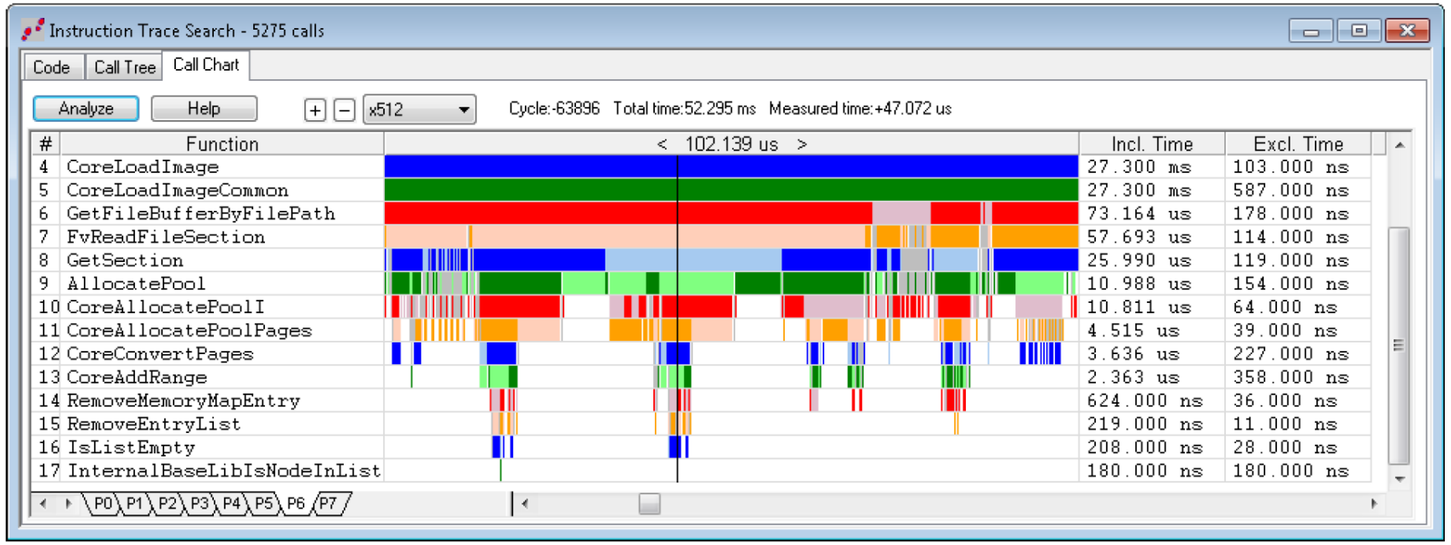
“New” Intel Trace Features

- Instruction Trace (Intel Processor Trace)
- Event Trace (Intel Trace Hub)

Between the two, provides for full system debug: testing the interaction of hardware and software as they produce complex system behaviors.

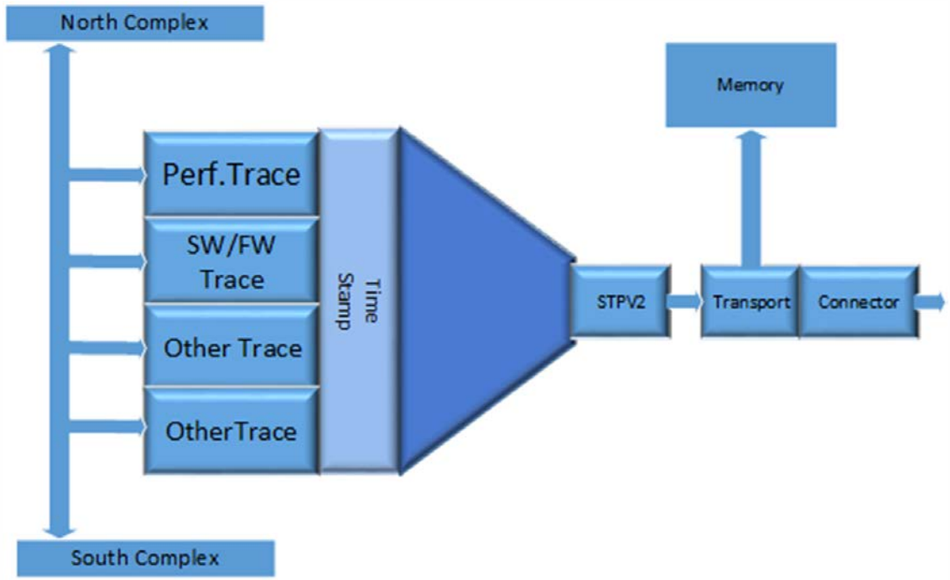
Intel Processor Trace (IPT)

- Globally timestamped
- Highly compressed; no significant impact on execution speed
- Trace buffer in system memory



Intel Trace Hub (ITH)

- Logic that comprises trace sources, a global hub with timestamp, trace destinations, and a trigger unit
- A sink device for writes from cores and any other trace sources
- Acts as a PCI device, and aligned with industry standards
- Trace sources: AET, ME, SW/FW, etc.
- Trace destinations include:
  - MTB (8kB, out of reset)
  - System Memory (after MRC)
  - Direct Connect Interface – DCI (out of reset, supports streaming trace)



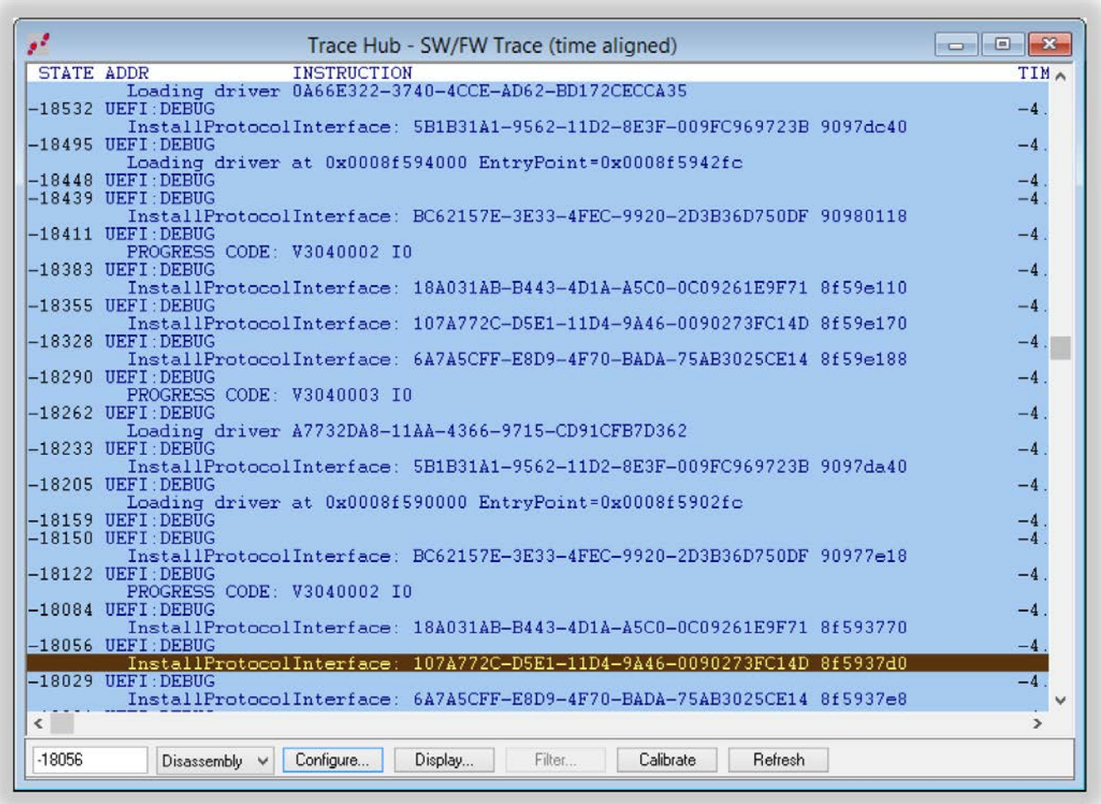
ITH Sources: AET

Event Type	Event SubTypes	Description
HW/SW Interrupt	HW_INTR	HW interrupt trace
IRET	IRET	IRET trace
Exception	Exception	Exception, fault, trap trace
MSR	RDMSR, WRMSR	MSR trace
Power Management	POWER_ENTRY, POWER_EXIT	Power management
IO	PORT_IN, PORT_OUT, PORT_IN_ADDR	IO trace
SGX	AEX, EENTER, ERESUME, EEXIT	SGX trace
CODE_BP	CODE_BP	Code breakpoint trace
DATA_BP	DATA_BP	Data breakpoint
FIXED_INT	SMI, RSM, NMI	“Fixed” interrupt trace
SW_POWER	MONITOR/MWAIT	MONITOR/MWAIT trace
WBINVD	WBINVD_BEGIN, WBINVD_END	Write-back invalidate trace

ITH Sources: SW/FW

SW/FW Trace

- "At-Speed Printf" (ASPF)
  - Printf pointer goes to Trace Hub, and the PC host processes string
  - Speeds up debug build boot
  - Avoids backpressure from serial port and printf code execution
  - Great for "Heisenbugs"
- Timestamped, and can be correlated with IPT, AET and other run-control and trace data



ITH Sinks

- MTB (2kB – 8kB; available out of reset)
- System memory (post-MRC)
- Direct Connect Interface (DCI) – streaming out of reset
  - DbC3: USB Type A/C, S0 power state only
  - DbC2: USB Type A/C, S0ix debug, survives Sx power state transitions and warm/cold resets

Setting up ITH and At-Speed Printf

- ITH is configured in BIOS
- Access it early before it gets “hidden”
- Build DEBUG printf “hooks” replaced with calls to system trace library
  - Typically DEBUG, RCPRINTF, and ASSERT_EFI_ERROR
- Use printf as you normally would

Setup: Implementation Steps

Add ASSET System Trace Library to MdePkg.dsc :
MdePkg/Library/BaseDebugLibSystemTrace/BaseDebugLibSystemTrace.inf
and use ASSET-provided BaseDebugLibSystemTrace.inf and header and .c files. The Trace Library can now be included.

1. Modify within the PlatformPkg.dsc file:
   DebugLib|MdePkg/Library/BaseDebugLibSerialPort/BaseDebugLibSerialPort.inf
   to
   DebugLib|MdePkg/Library/BaseDebugLibSystemTrace/BaseDebugLibSystemTrace.inf

OR

2. Use compiler option:
   In build script, VAR_BUILD_FLAGS= …….-DASSET_SYSTEM_TRACE=TRUE
   And for each module add conditional code:

```
!if $(ASSET_SYSTEM_TRACE) == TRUE
   DebugLib|MdePkg/Library/BaseDebugLibSystemTrace/BaseDebugLibSystemTrace.inf
!else
   DebugLib|MdePkg/Library/BaseDebugLibSerialPort/BaseDebugLibSerialPort.inf
!endif
```

\MdePkg\Library\BaseDebugLibSerialPort\DebugLib.c

```
VA_START(Marker, Format);
AsciiVSPrint(Buffer, sizeof(Buffer), Format, Marker);
VA_END(Marker);
// Send print string to a Serial Port
SerialPortWrite((UINT8*)Buffer, AsciiStrLen(Buffer));
```

\MdePkg\Library\BaseDebugSystemTrace\DebugLib.c

```
// Send print string to a Serial Trace Device
VA_START(Marker, Format);
SystemTraceWrite((UINT8*)Format, AsciiStrLen(Format),
Marker);
VA_END(Marker);
```

Instruction Trace + Event Trace (DCI)

Pre-MRC completion

- Instruction Trace: LBR
- Event Trace: Trace Hub out of reset (AET w/LBR, ME, ASPF, …)

Post-MRC completion

- Full Intel Processor Trace to System Memory
- Event Trace: Trace Hub out of reset (AET w/LBR, ME, ASPF, …)

Demo Configuration

SourcePoint debugger

“Special” USB cable

Intel DesignInTools, DataPro

Ice Lake Client

Demo

Call to Action

- Take advantage of UEFI learning/ development opportunities
  - Debugging Intel Firmware using DCI & USB 3.0
  - UEFI Debug with Intel Architectural Event Trace
  - ASSET blog
- Access ASPF support files at www.asset-intertech.com/sourcepoint-academy/at-speed-printf

Questions?

Thanks for attending the UEFI 2021 Virtual Plugfest

For more information on UEFI Forum and UEFI Specifications, visit http://www.uefi.org

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