Keystone Advanced Debug

Agenda

- Debug Architecture Overview
- Advanced Event Triggering
- DSP Core Trace
- System Trace
- Application Embedded Debug Support
- Multicore System Analyzer (MCSA)

Indicates features that are new on the Keystone generation of the C6000 Family

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Debug Architecture Features

- Advanced Event Triggering
  - Hardware Breakpoints/Watchpoints
  - Event Monitoring/Counting
  - Core Trace Control
- DSP Core Trace
  - Export Program, Timing, Data, Event Info
- System Trace
  - Export Bus Statistics and Events
  - Export Software Messages
- Cross Triggering

Trace Data Capture Mechanisms

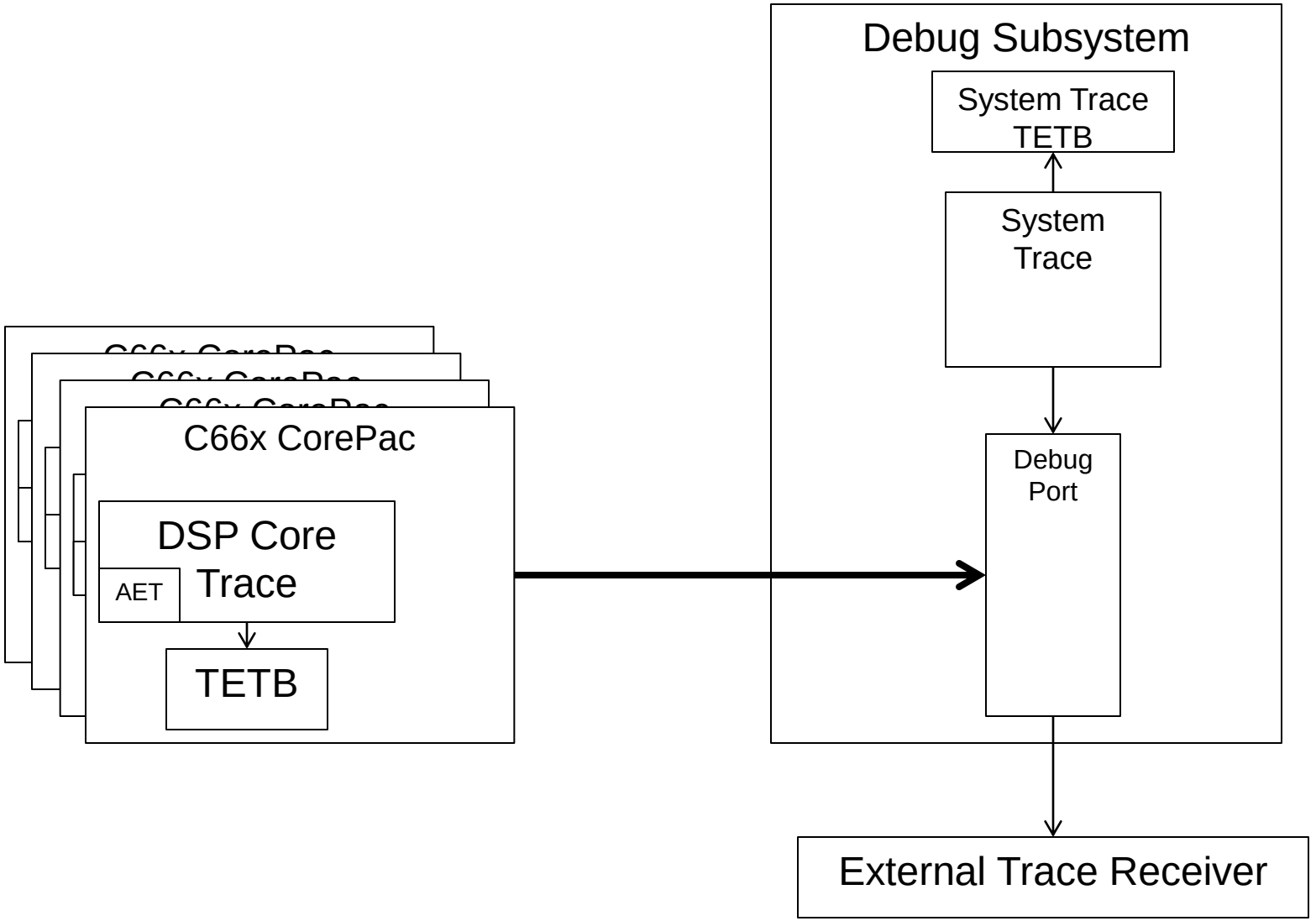
- DSP Core Trace
  - Debug Port EMU pins for export to an external receiver*
  - Dedicated TI Embedded Trace Buffer (TETB) 
    - 4Kb on each core
- System Trace 
  - Debug Port EMU pins for export to an external receiver*
  - System Level TI Embedded Trace Buffer (TETB)
    - 16Kb per device

* XDS560v2 Pro (In Beta) = 2GB

Embedded Trace Buffer (TETB)

- Can be optionally drained “on the fly” to L2, shared, or external memories
- Can trigger event on ½ full status or full status
- Advantages
  - Virtually extends the limited ETB size
  - Data can be streamed from the device via Ethernet or any other transport

Debug Subsystem



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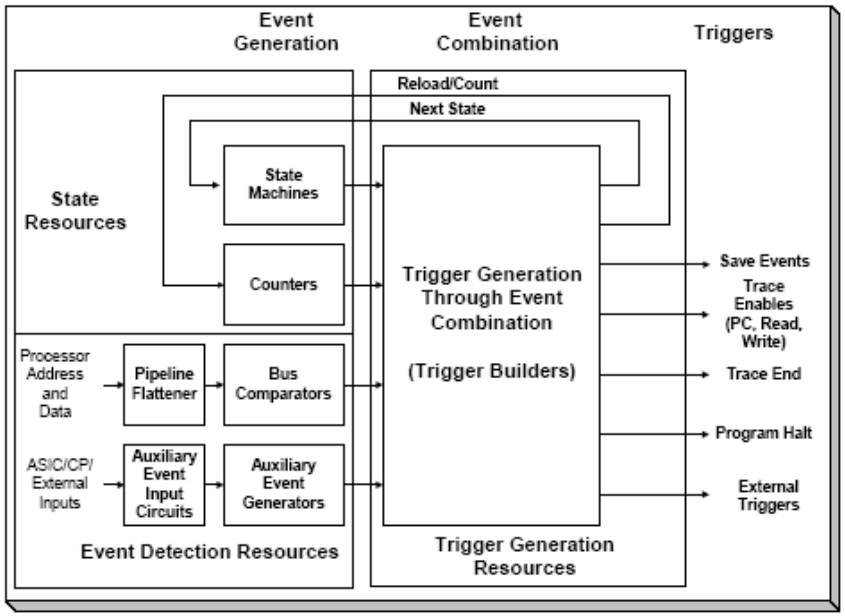
Advanced Event Triggering (AET)

- Logic that can monitor
  - Program Bus Activity
  - Data Memory Bus Activity
  - System Events
- Non-Intrusive / Real Time
- Programmable at load or run time



Advanced Event Triggering Inputs

- Input Logic
  - 6 Dual Range Address Comparators
    - 4 Program/Data Address w/ Value Qualify
    - 2 Program Address Only
  - 4 Auxiliary Event Generators
  - 4 State Sequencer
  - 2 Timers/Counters
    - With Min/Max Watermark Capabilities
  - ….

Advanced Event Triggering Outputs (Triggers)

- Output Logic (Triggers)
  - CPU Halt Request*
  - Interrupt
  - Counter Inc/Dec/Reset
  - Timer Start/Stop
  - Store Trace Sample (7 Streams)
  - Start Trace (7 Streams)
  - State Sequencer Transition
  - ….

*Halt Request ignored when debugger not connected

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DSP Core Trace

- Core Trace (aka XDS560 Trace, CPU Trace)
  - Allows real-time, non intrusive, cycle accurate logging of PC (PC Trace) and Data (Data Trace) activity on the DSP Memory Buses.
  - Captured Trace data is compressed by on-chip hardware, passed either to the ETB or an external receiver, and then decoded on the host (with CCS or a stand alone decoder)
- Event Trace
  - Event Trace is similar to PC trace, but allows selection of a subset of events that are tagged within the Trace Output.

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System Trace

- Allows System Level monitoring of Application Events and Resources
- Two Options
  - Software Messages
  - Hardware Messages – Common Platform Tracer (CPTracer)

Software Messaging

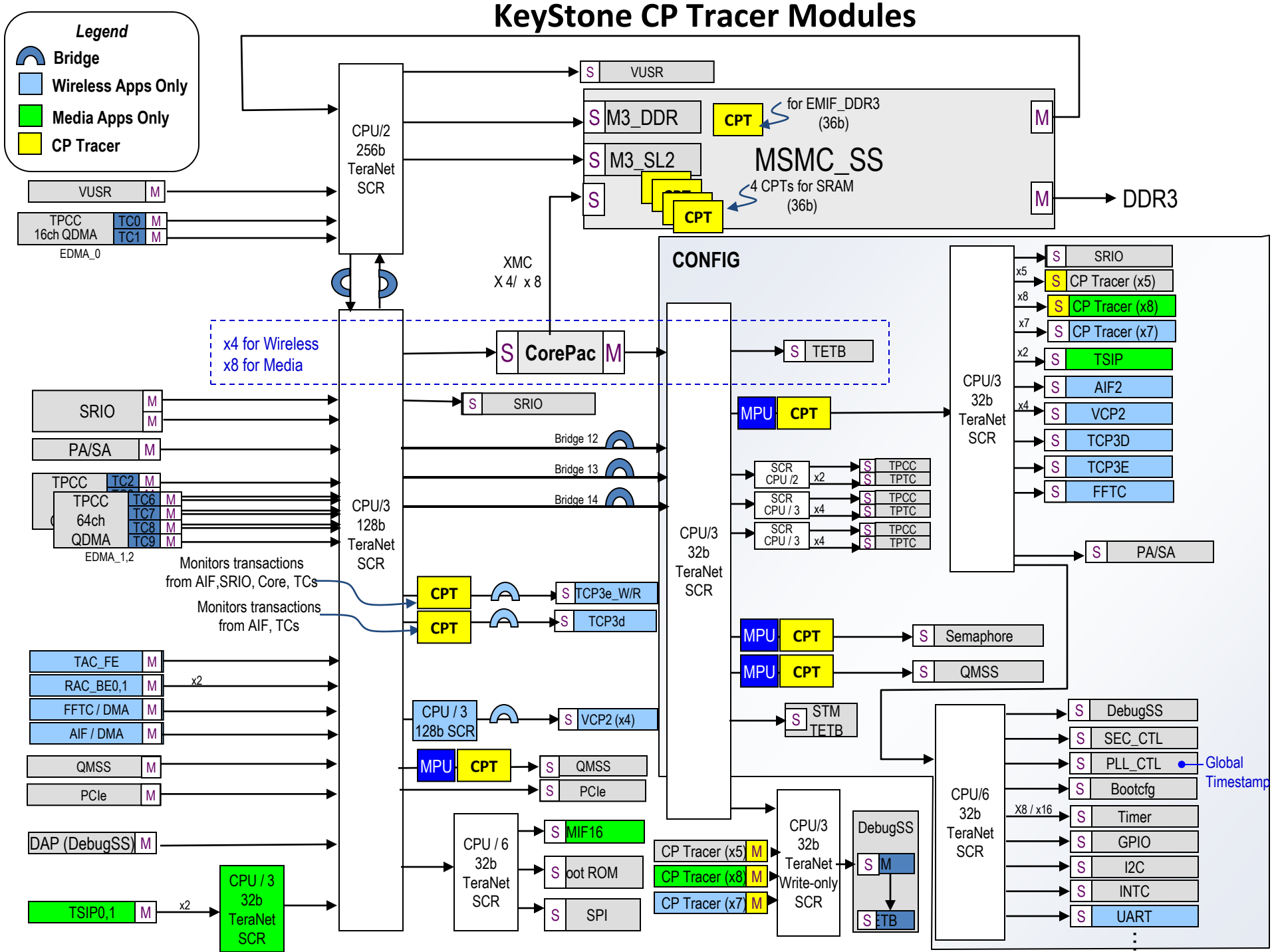
- Enabled By System Trace Library (STMLib)
- Advantages over Standard Printf
  - Real-time
  - System Level Cycle aligned
- Up to 240 User Defined Channels
- Reduced capability library build (compact) also provided (< 1K)

STMLib is a component of the CToolsLib Family of libraries
Download free via Gforge: https://gforge.ti.com/gf/project/ctoolslib/frs/

Common Platform Tracer (CPTracer)

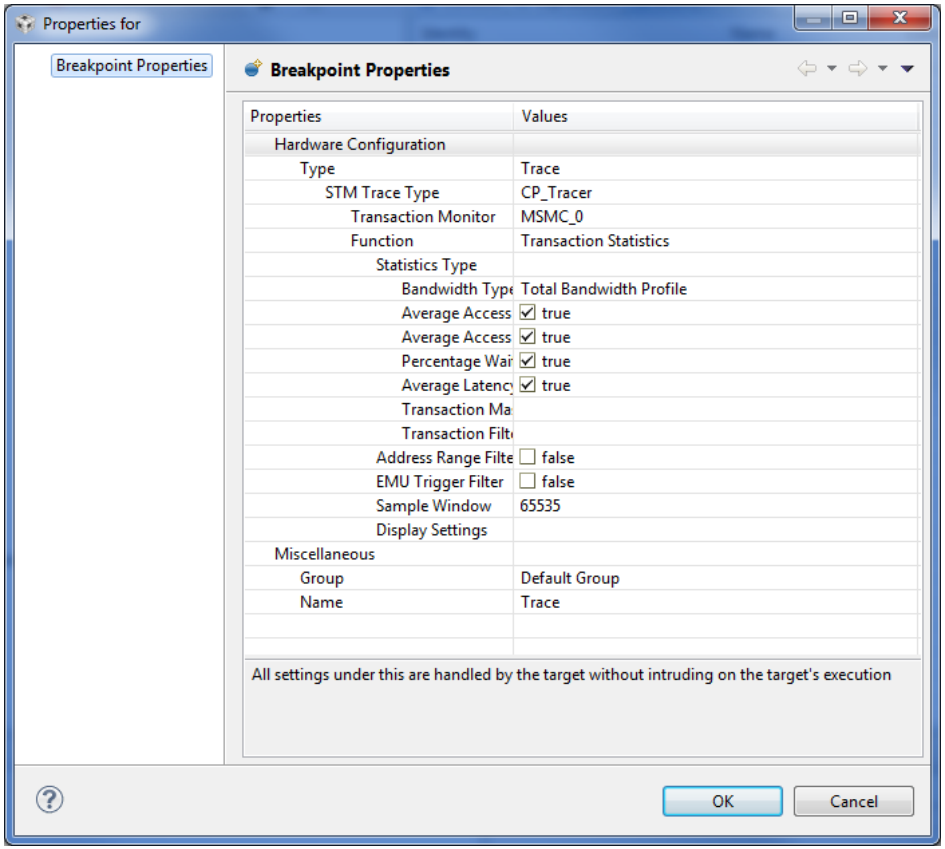
- CPT Modules - Provide data for slave buses.
  - Profiling: Periodically export STM Messages for statistics counters
    - Throughput Counter 0,1 – Bytes of slave acknowledged accesses
    - Wait Counter – Number of cycles a master access must wait for slave acknowledge
    - Access Counter – Number of unique transactions
  - Event Logging
    - New Request
    - Last Read
    - Last Write

KeyStone CP Tracer Modules



Configuration

- CCS Breakpoint Manager



- CPTracer Library (CPTLib)
  - Use Case based APIs
  - Enable/Disable functions allow isolation of Trace Data generation

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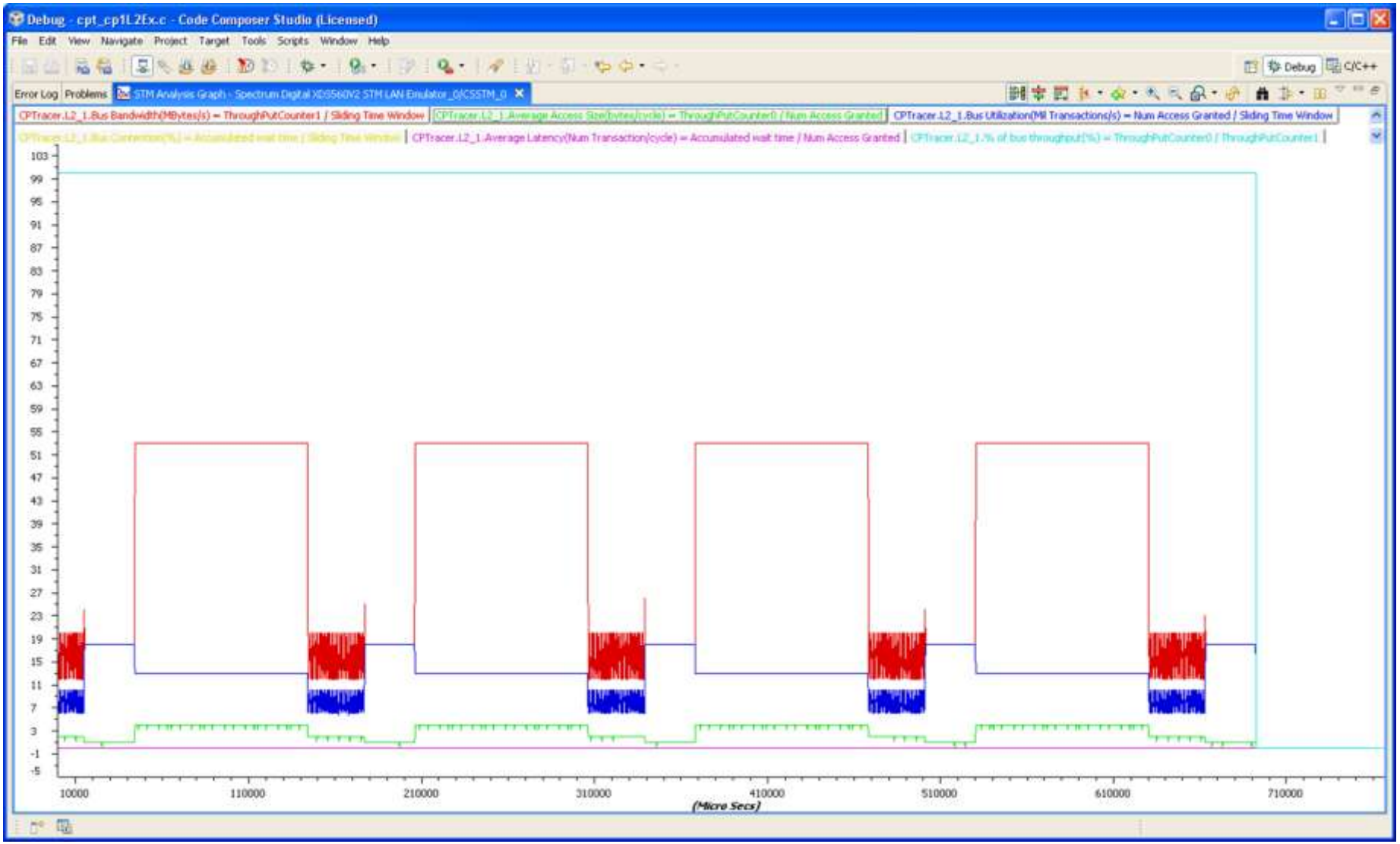
CPTracer Sample Ouput



http://processors.wiki.ti.com/index.php/CorePac_1_L2_CPT_-_CCS_setup_XDS560v2_System_Trace_Example

Cross Triggering

- Provides a means to propagate debug events from one processor to another.
- Other processors can generate actions upon cross trigger
- Sample Debug Events
  - Processor Entering Debug State
  - Watch Point Match
  - ETB Full
- Sample Debug Actions
  - Restart
  - Interrupt Request
  - Start Trace

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Application Embedded Debug Support

- CToolsLib – A suite of libraries that can be used for embedding debug elements into an application
  - AETLib
  - ETBLib
  - CPTLib
  - DSPTraceLib
  - STMLib

Available Free Via GForge: https://gforge.ti.com/gf/project/ctoolslib/frs/

AETLib

- Provides programmatic access to the Advanced Event Triggering logic
- Advantages
  - Reuse of limited AET resources (task stack monitoring)
  - More granularity for enabling/disabling AET/Trace at specific points of the application
  - Capture of Trace data from fielded devices

ETBLib

- Provides application access to configuration of the embedded trace buffer
- Advantages
  - ETB can be configured without Debugger connection
  - Dynamic draining of ETB is supported
    - Events generated on half full and full
    - Data can be moved from ETB into internal memory and passed off via any transport (Ethernet, Srio, etc)
    - Virtually extend the size of the ETB

System Trace Libraries

- STMLib
  - Application Interface to System Trace Software Messages
  - Advantages
    - Small function overhead
    - Real-Time
    - System Level Time Stamp
- CPTLib
  - Application Interface to Common Platform Tracer Configuration

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Multicore System Analyzer(MCSA)

- Suite of tools providing real-time visibility into performance and behavior of an application.
  - Information collected in various ways
- Advanced Tooling Features:
  - Real-time event monitoring
  - Multicore event correlation
  - Correlation of software events, hardware events and CPU trace
  - Real-time profiling and benchmarking
  - Real-time debugging

http://processors.wiki.ti.com/index.php/Multicore_System_Analyzer

Analysis Features

- Benchmarking: Finding out how long it takes some action to complete. Includes 'context aware' benchmarking for multi-threaded analysis
- CPU and Task Load Monitoring: real-time visibility into how busy your system really is
- O/S Execution Monitoring: monitoring task switches and the state of kernel objects such as semaphores
- Filtering events
- Multicore Event Correlation

Current/Future Features

Current

- Ethernet Transport
- JTAG Stop-Mode
- JTAG Run-Mode
- Execution Graph
- CPU Load
- Task Load
- Benchmark/Duration
- Context Aware Profile
- Statistics / Count Analysis

Future

- ETB Draining
- CPU Trace, STM, UIA Correlation
- Logging on Linux
- Realtime Config & Software Instrumentation Control
- USB Transport
- STM Transport
- Remote Debug
- Back Trace

MCSA User's Guide

System Analyzer 1.0
System Analyzer 1.1