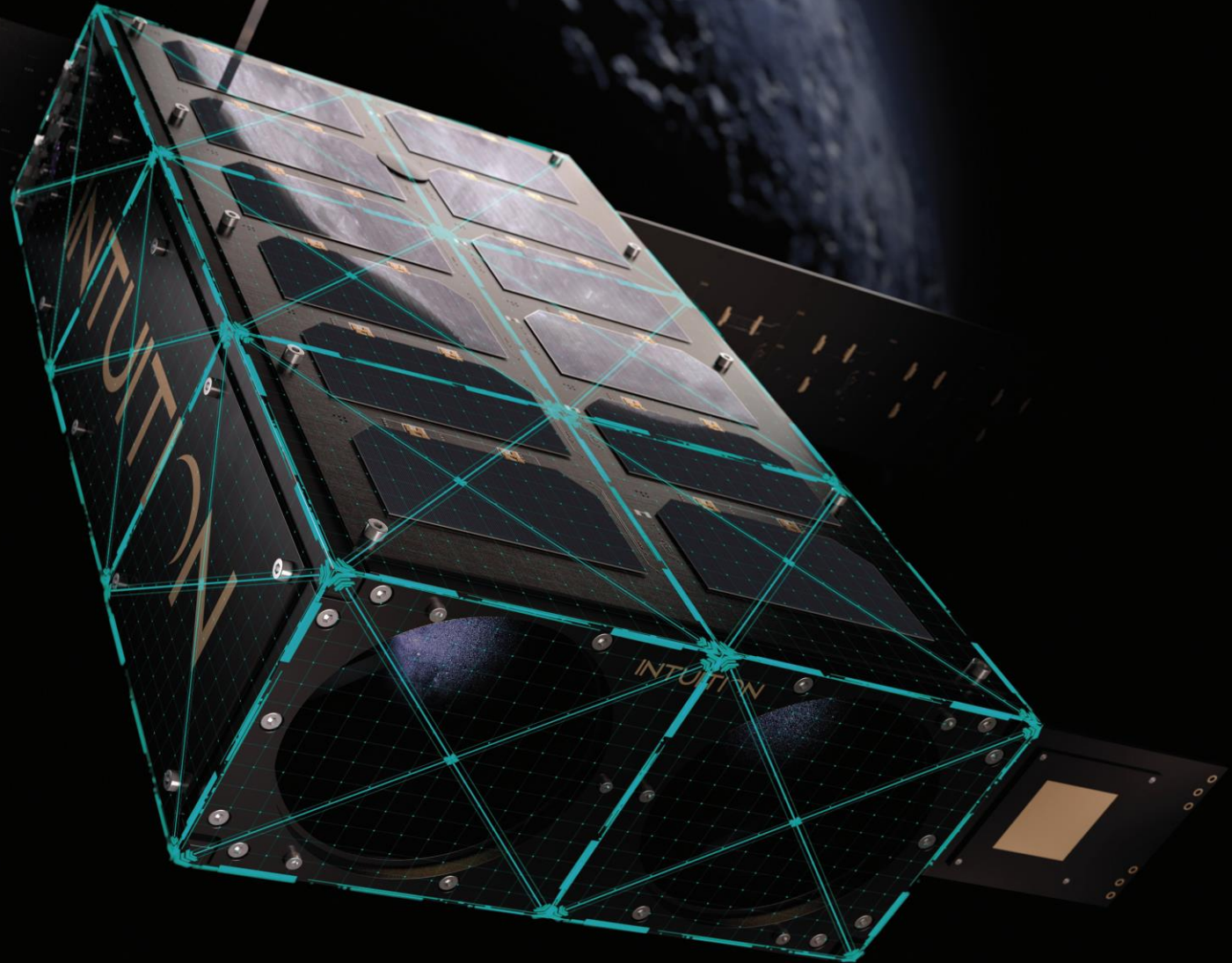




ARM Cortex-M tracing with Orbcodes



ARM tracing components

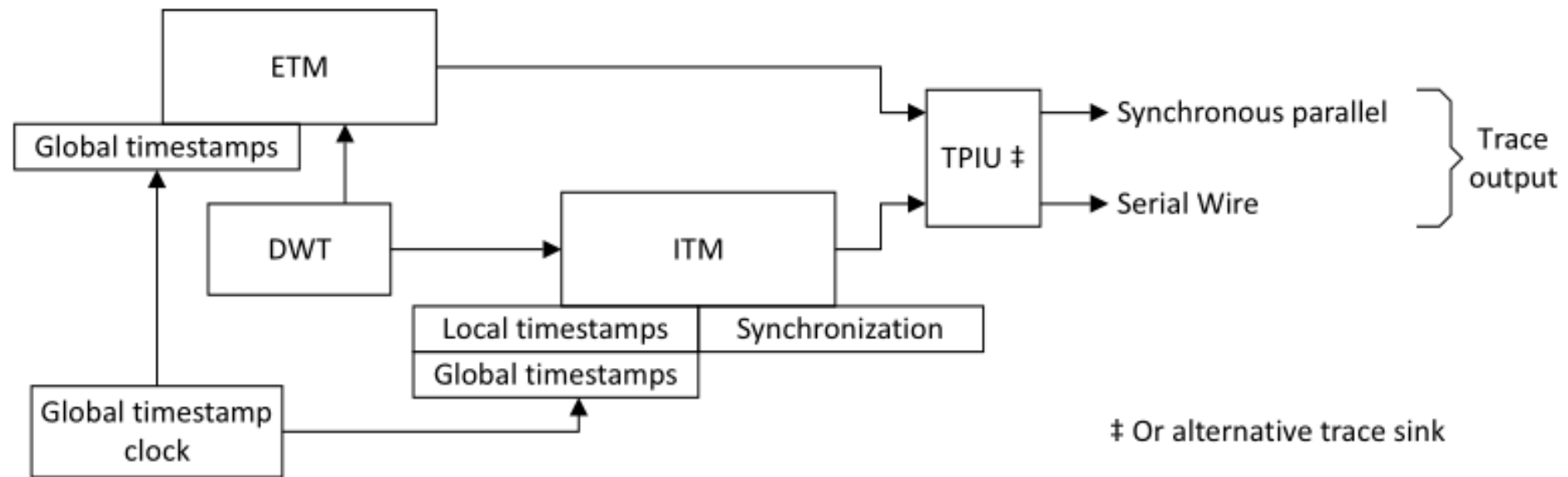


Figure C1-1 Relationship between ITM and other debug components

Documents

- ARMv7-M Architecture Reference Manual
 - Description of tracing components
- ETM Architecture Specification
 - Description of ETM component
- Cortex-Mx Technical Reference Manual
 - Cortex-M limitations
- MCU documentation (Reference Manual, Datasheet)
 - Vendor specific limitations (what is implemented what is not)
 - How to enable – GPIO setup, clocks
- + others referenced documents

Trace Port Interface Unit (TPIU)

- Output trace data outside of MCU
- Output protocols
 - Serial Wire Output, UART
 - Serial Wire Output, Manchester
 - Parallel Trace, Clock + N (1-4) bits
- Output formats
 - Raw ITM (SWO only, ETM discarded)
 - Formatted (ITM/ETM wrapped in TPIU packets)



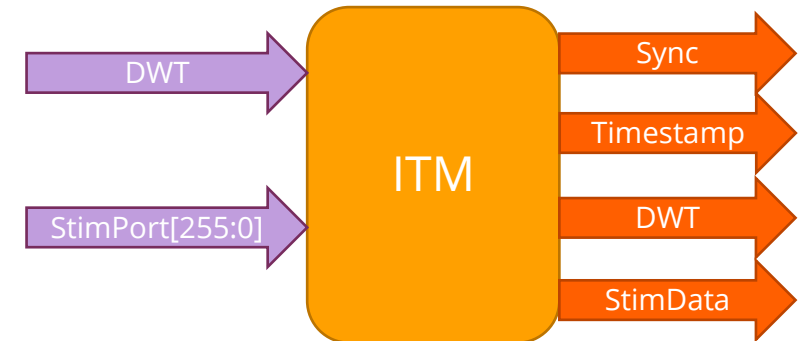
Trace Port Interface Unit (TPIU)

- TraceBusID – differentiates trace sources
 - ITM_TCR.TraceBusID – ITM
 - Set to 1
 - ETM_TRACEIDR – ETM
 - Set to 2



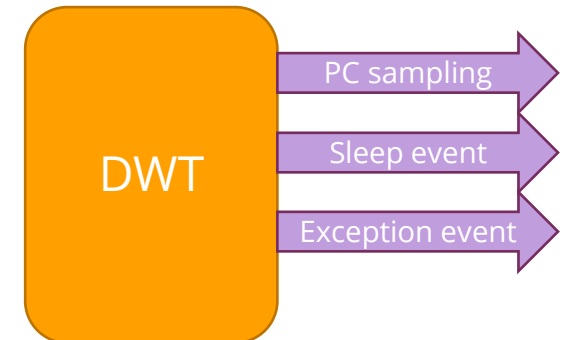
Instrumentation Trace Macrocell (ITM)

- Up to $8*n$ (< 255) stimulus ports for user-defined data output
 - 32-bit wide
 - n – implementation defined
- Synchronization packets
 - Configurable interval (with DWT registers)
- Timestamp
 - Retrieve MCU tick counter

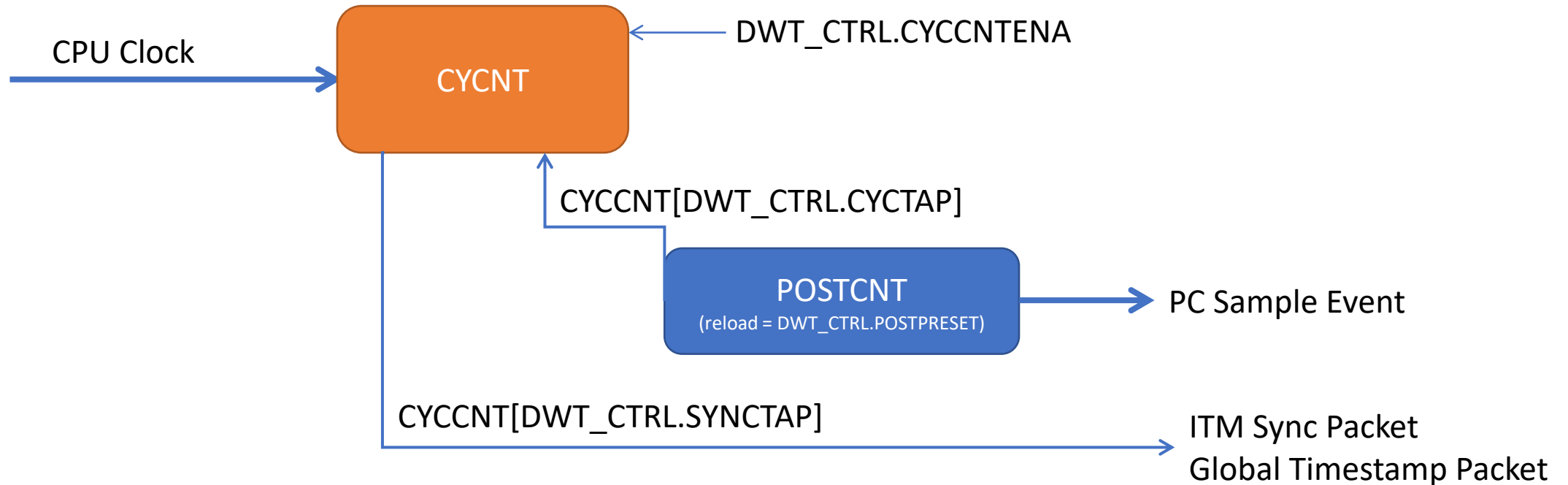


Data Watchpoint and Trace (DWT)

- PC sampling
- Exception entry/exit event
- Watchpoints implemented here

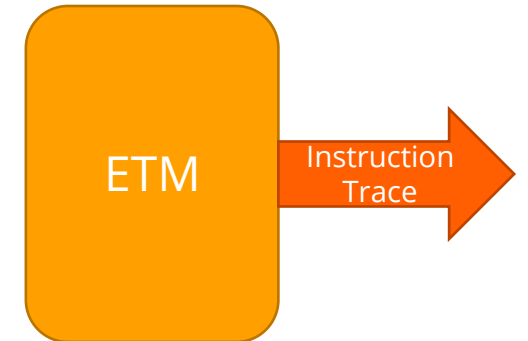


Data Watchpoint and Trace (DWT)



Embedded Trace Macrocell (ETM)

- The Beast
- Trace every executed instruction
- Can stall CPU
- Triggering
- Check Cortex-M TRM details

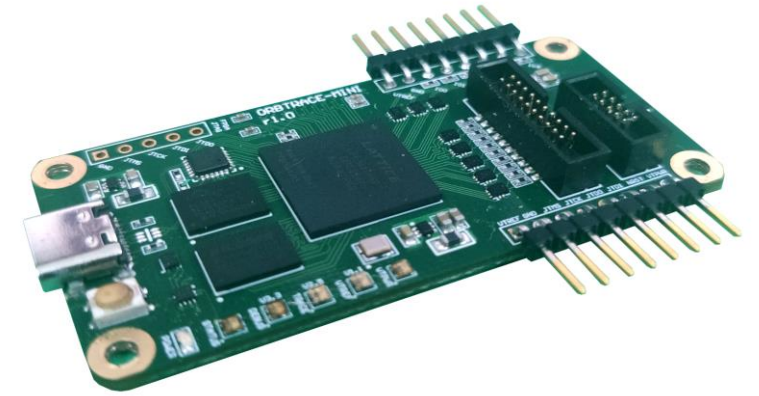


How to configure?

- Configure GPIO (per MCU docs)
- Configure TPIU/ITM/DWT/ETM (per ARM docs)
- Configure using:
 - Code (on startup, on command)
 - OpenOCD (TCL script)
 - GDB

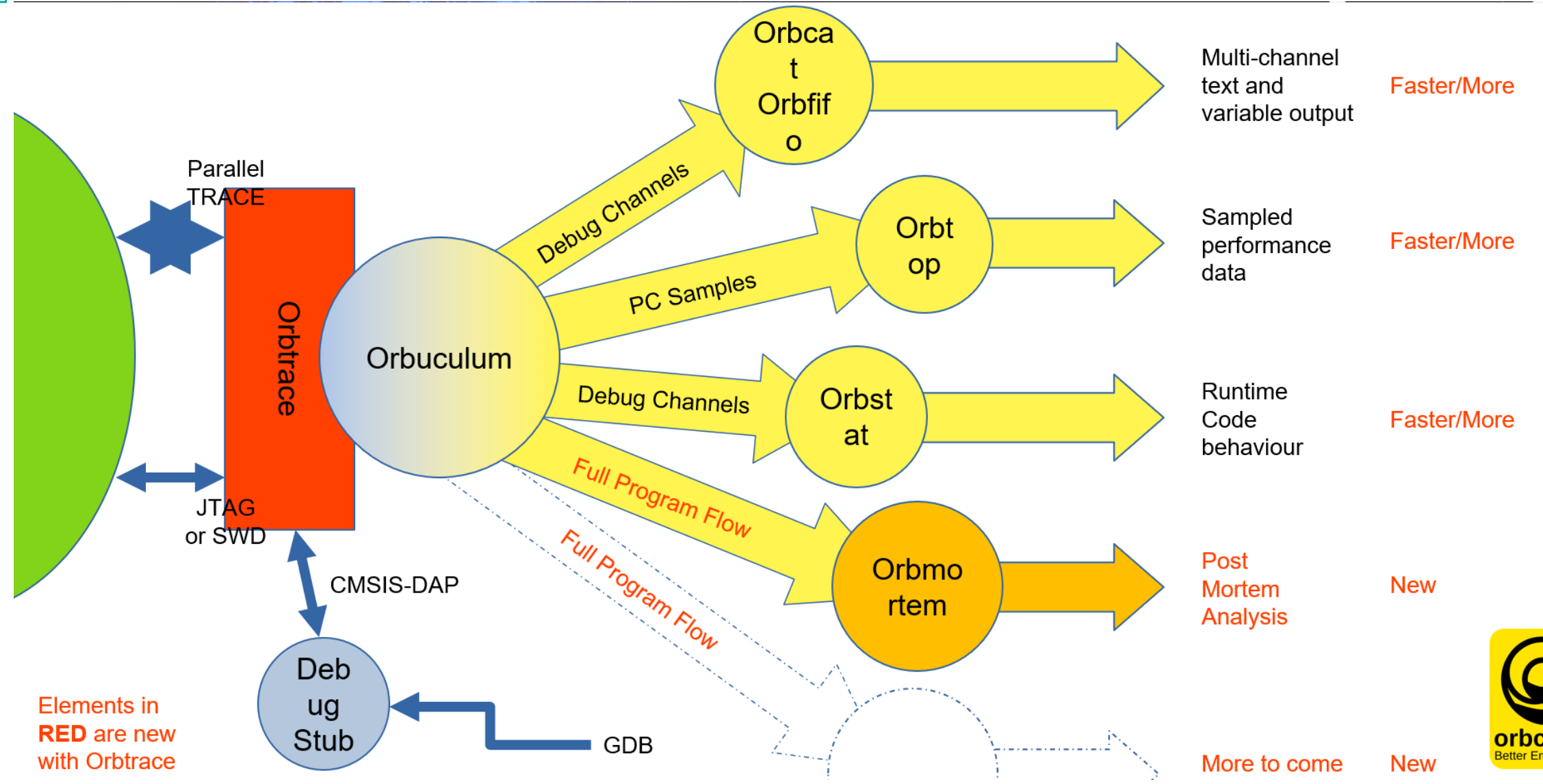
Orbtrace

- Open (bitstream/schematics)
- FPGA-based
- Debug probe JTAG/SWD (CMSIS-DAP)
- Parallel trace receiver
- SWO receiver
- Fast!



orbuculum

- Tools for handling ARM Trace output
 - Parallel trace from Orbtrace
 - SWO/UART trace from USB adapter
- Fan-out architecture
 - orbuculum – receives trace output from hardware and exposes over TCP
 - orb* tools – receive stream from orbuculum and interpret it in various ways
 - Receive stream over network!



2022

Elements in RED are new with Ortrace





Verbosity = 2

orbuculum -v 2 -m 1000

Start concentrator

Report link usage every 1000ms

ITM TraceBusID = 1 (ITM)

obcat -t 1 -c 4,%c

Print data from
ITM stimports

Print data from 4 ITM
Stimulus Port as characters

ITM TraceBusID = 1 (ITM)

orbtop -t 1 -e file.elf

Print PC
sampling

ELF file (for functions/lines)