Multi-core Time synchronization

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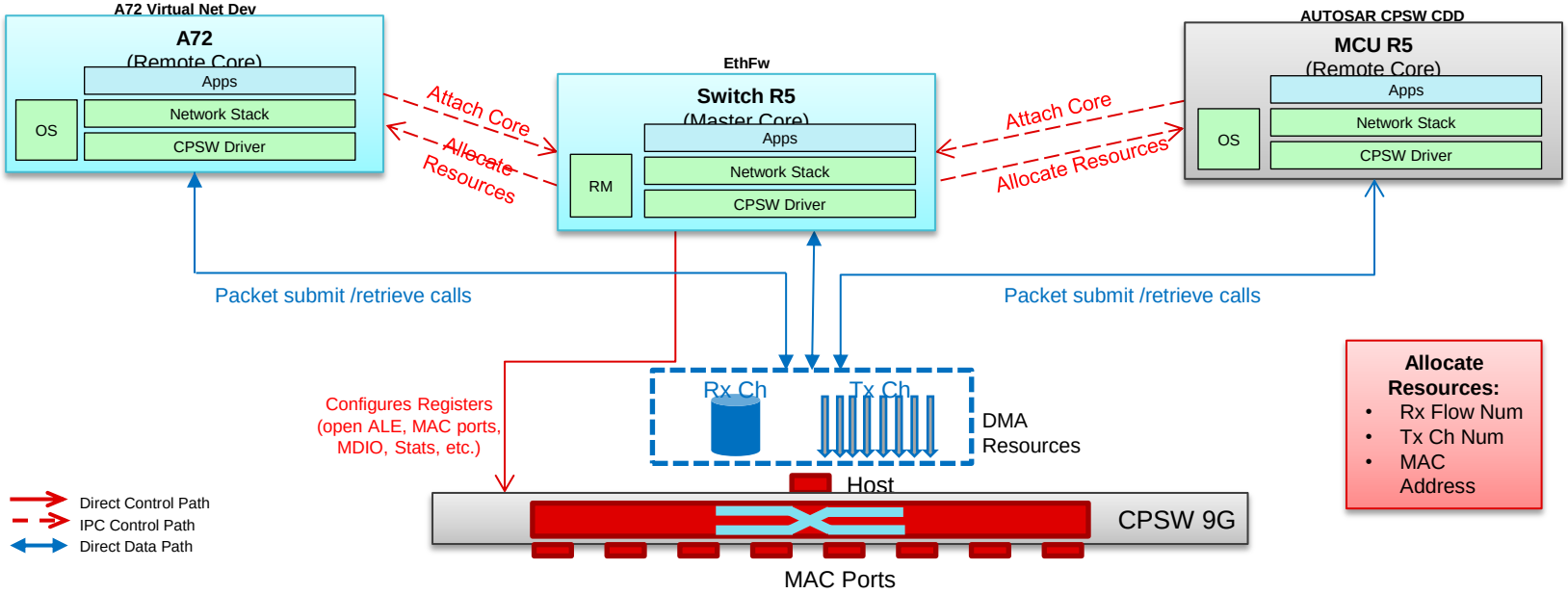
Why Multi-core time synchronization?

- In Multi-core Ethernet architecture of Jacinto 7 family of devices, the control path of CPSW9G IP is solely controlled by the Main domain R5 core(EthFw), preventing other cores in the SoC to change CPSW9G configurations.
- Common Platform Time Sync (CPTS), one of the IP sub-module of CPSW9G used for packet time-stamping is also controlled solely by the EthFw.
- EthFw uses this CPTS timer and synchronizes itself with a master in the network using PTP stack.
- So, a mechanism to provide time synchronization support to time-sensitive applications on remote cores is necessary in Ethernet firmware.

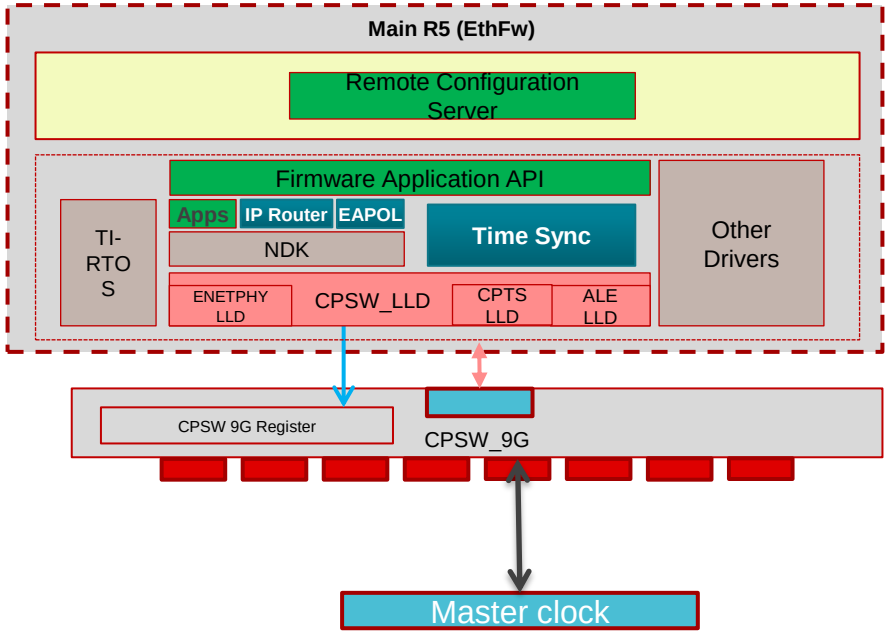
Multi-core Ethernet architecture



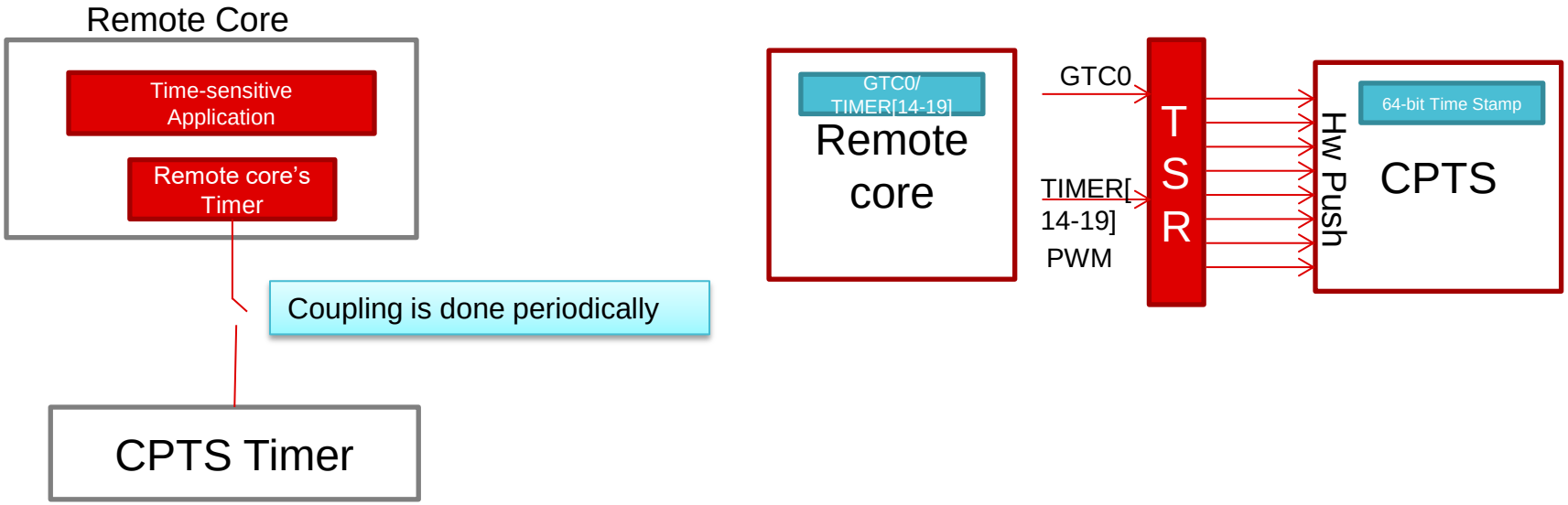
- Once the switch is configured via the firmware on Main R5, other CPUs on the SoC can perform network IO simultaneously without involving the Main R5 core.
- Subsequent packet IO can happen directly between the CPU specific network stack and switch HW via UDMA.

Multi-core Time-synchronization design

- Ethernet firmware running on Main R5 core configures Time Sync PTP stack and enables it.
- Time Sync PTP stack synchronizes CPSW's CPTS timer with the Master clock in network.
- Using Ethernet remote configuration framework, EthFw provides timer coupling support to remote cores, and let them subscribe for callback notifications.
- Ethfw uses Time Sync Router to route remote core timer's event to hardware push of CPTS timer.
- CPTS timer timestamps every hardware push event from remote core and returns the timestamps.

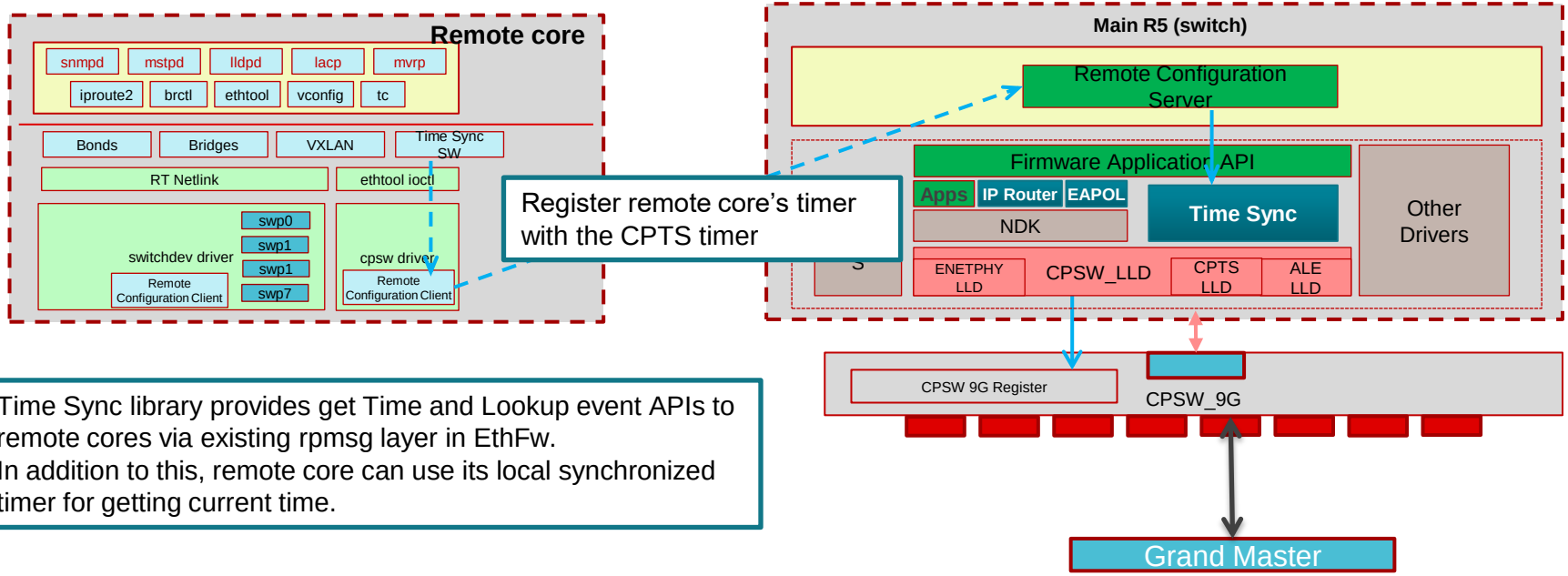


Time Sync Router Configuration



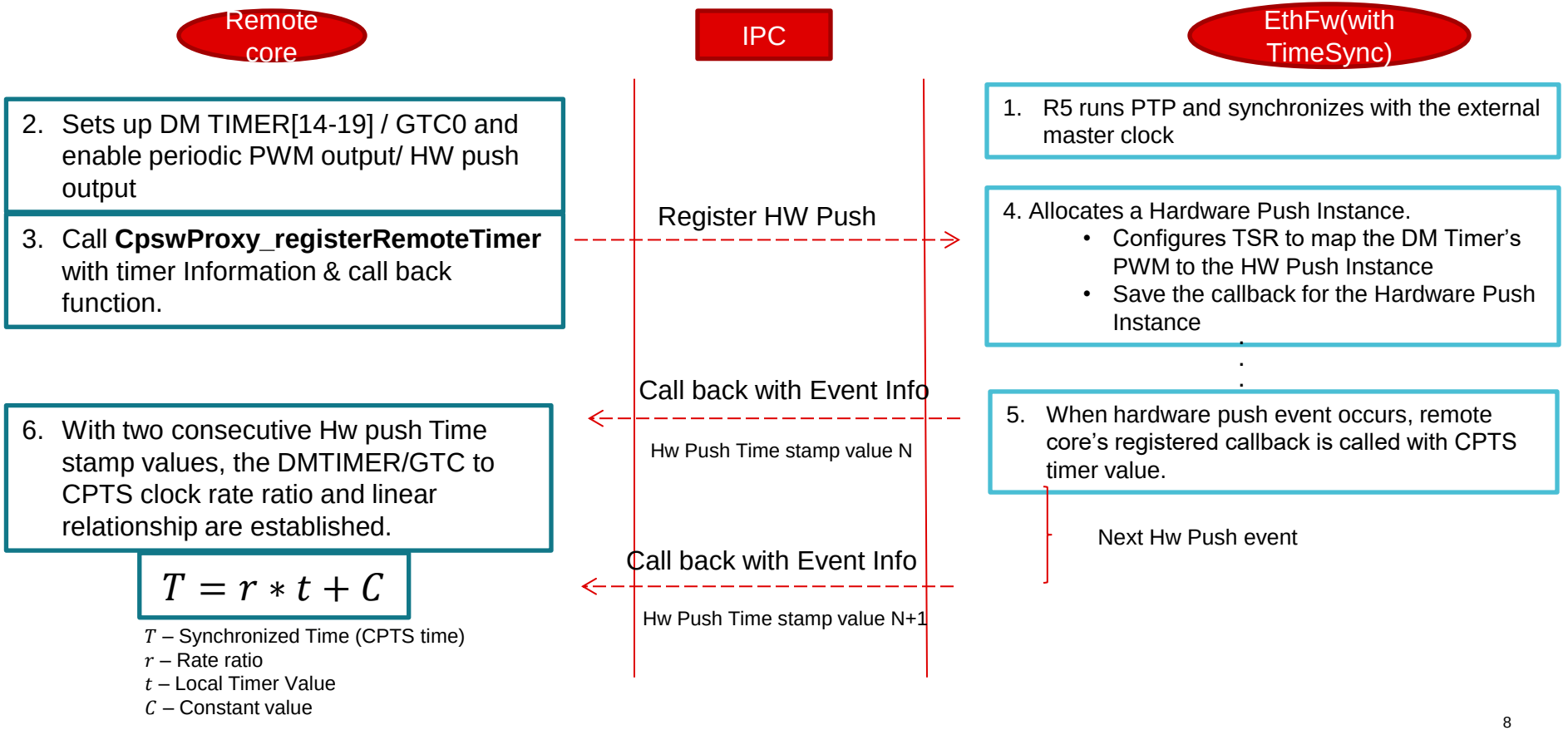
- Coupling between remote core's timer and CPTS timer is done through Hardware push events of CPTS and Time Sync Router(TSR).
- With this a linear relation is established between CPTS & remote timer.
- Once the relation is established, remote core can independently use this coupled timer locally.

Coupling remote core timer with CPTS



- Time Sync library provides get Time and Lookup event APIs to remote cores via existing rpmsg layer in EthFw.
- In addition to this, remote core can use its local synchronized timer for getting current time.

Multi – core Time Synchronization sequence



Example

- EthFw RTOS Server(MCU2_0) and EthFw RTOS Client (MCU2_1) demonstrates Multi-core time synchronization.
- EthFw RTOS Server enables Time Sync PTP stack on MAC port 2 in slave mode and synchronizes with available master clock in the network.
- EthFw RTOS Client registers GTC timer used by it for coupling using TSR.
- Using registered hardware push callback, client establishes a linear relation and stores it locally.
- Whenever Client calls **CpswRemoteApp_getSynchronizedTime(),** the API computes synchronized time using current GTC time and the established linear relationship with CPTS timer.

$$T = r * t + C$$

T – Synchronized Time
r – Rate ratio
t – GTC Timer Value
C – Constant value