

Real-Time Course 100 Topic 03

Intel® Time Coordinated Computing (Intel® TCC)

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Real-Time 100 Title

Real-Time 100 – Course Agenda

Topic 1: Introduction: Real-Time Computing

Topic 2: Linux Based Real-Time System

Topic 3: Intel® Time Coordinated Computing (Intel® TCC)

Topic 4: Time-Sensitive Networking (TSN) Overview

Topic 5: Intel® Edge Controls for Industrial (Intel® ECI)

Topic 6: Workload Consolidation in IIoT

Intel® TCC Value Proposition

Improved performance for latency-sensitive applications at system level



Simplifying the complex

Better out-of-box real-time performance and no need to learn intricate low-level concepts



Doing more with the same system

Maximum efficiencies by aggregating real-time and non-real-time applications on a single system



Future-proofing designs

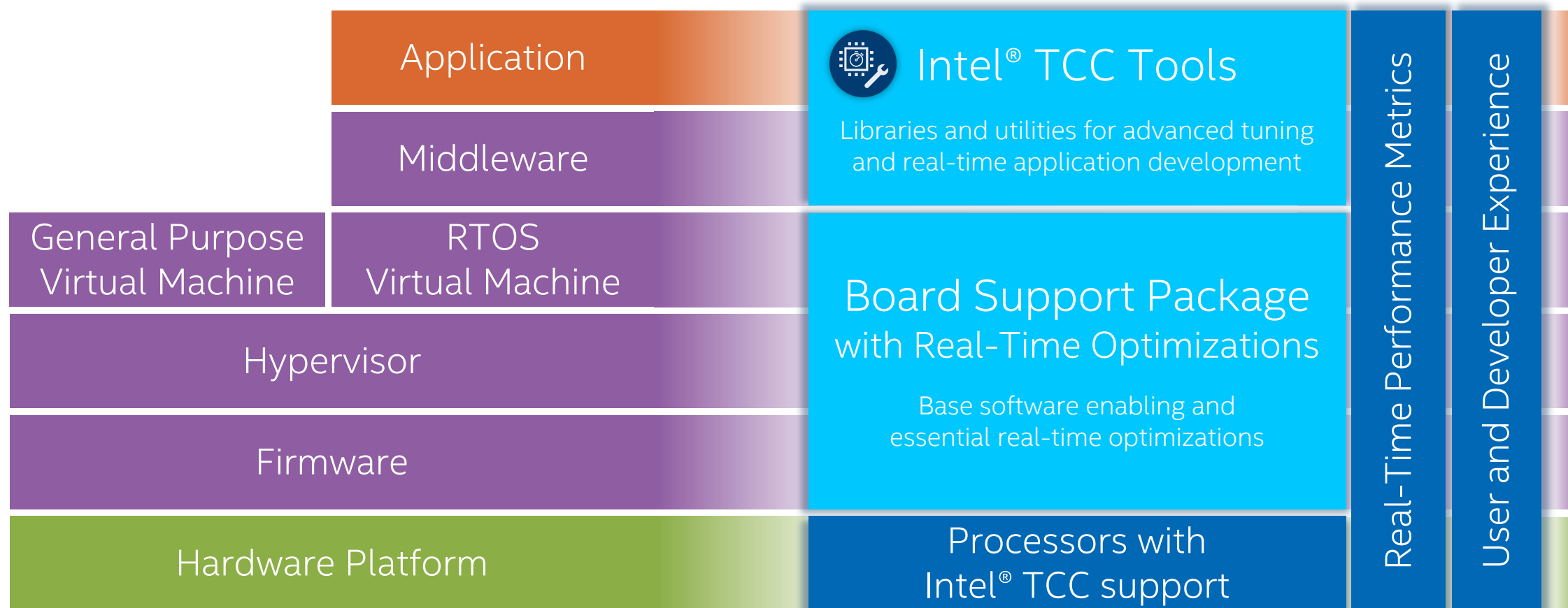
Scale between Intel Atom®, Intel® Core™ and Intel® Xeon® processors and across processor generations



Accelerating development

Faster time to market thanks to unified and consistent developer experience

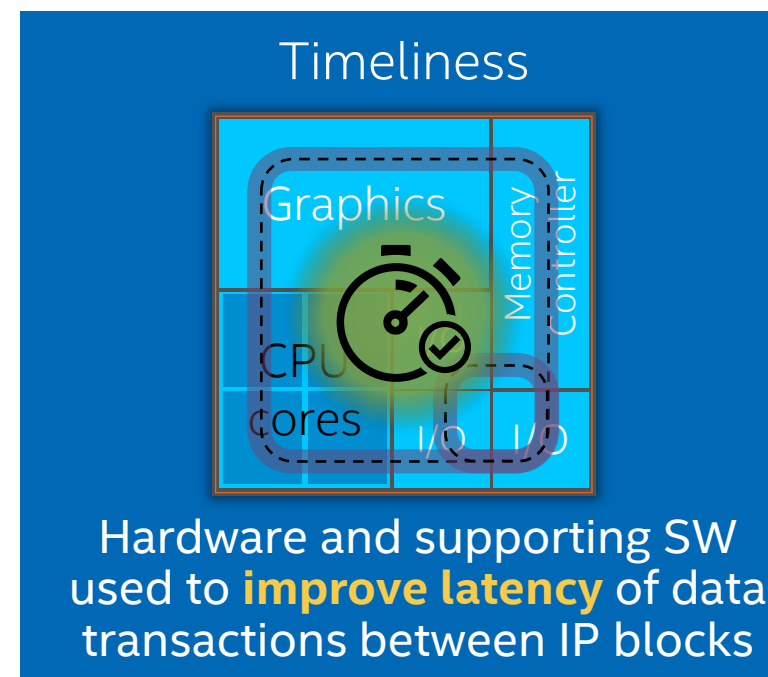
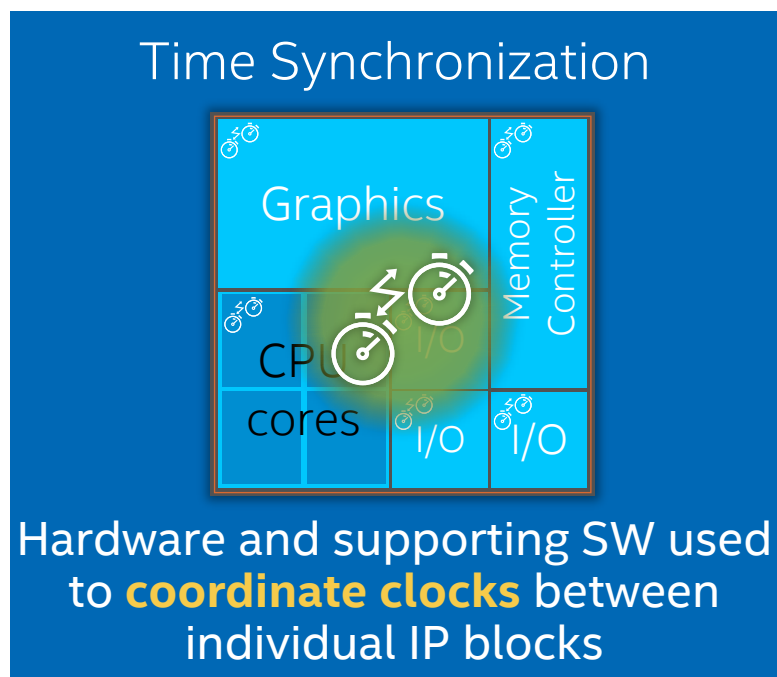
Intel® TCC Investments



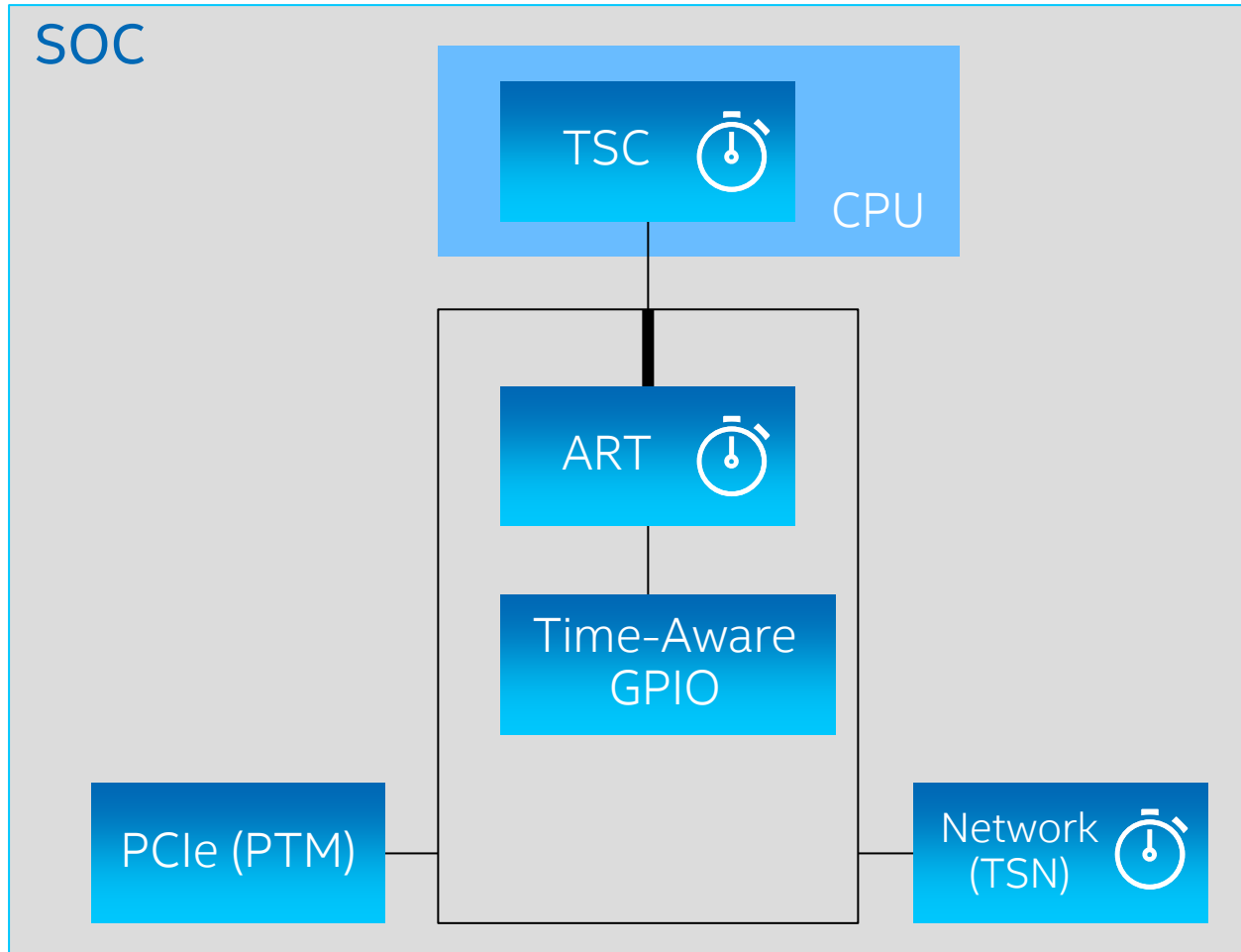
For workloads and configurations, visit www.Intel.com/PerformanceIndex. Results may vary.

Key Intel® TCC Capabilities

Intel® TCC is a set of features spread across multiple modules of Intel processors helping improving their real-time characteristics

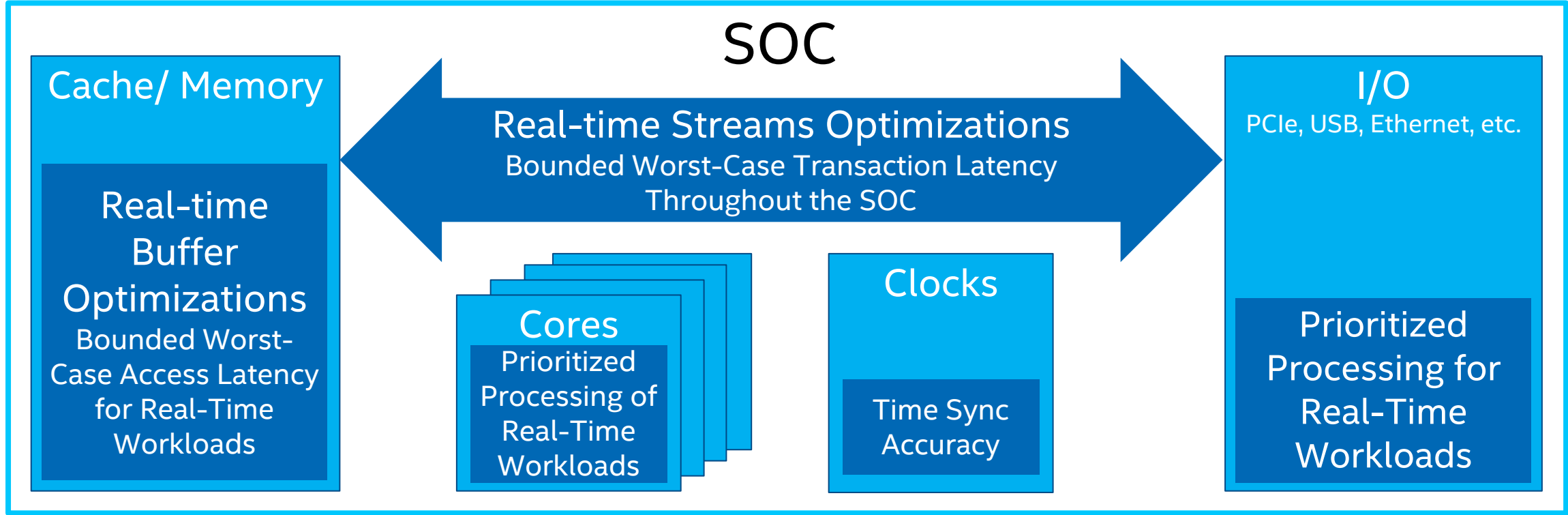


Intel® Time Coordinated Computing (Intel® TCC) Time Sync: Clock Synchronization within the Platform



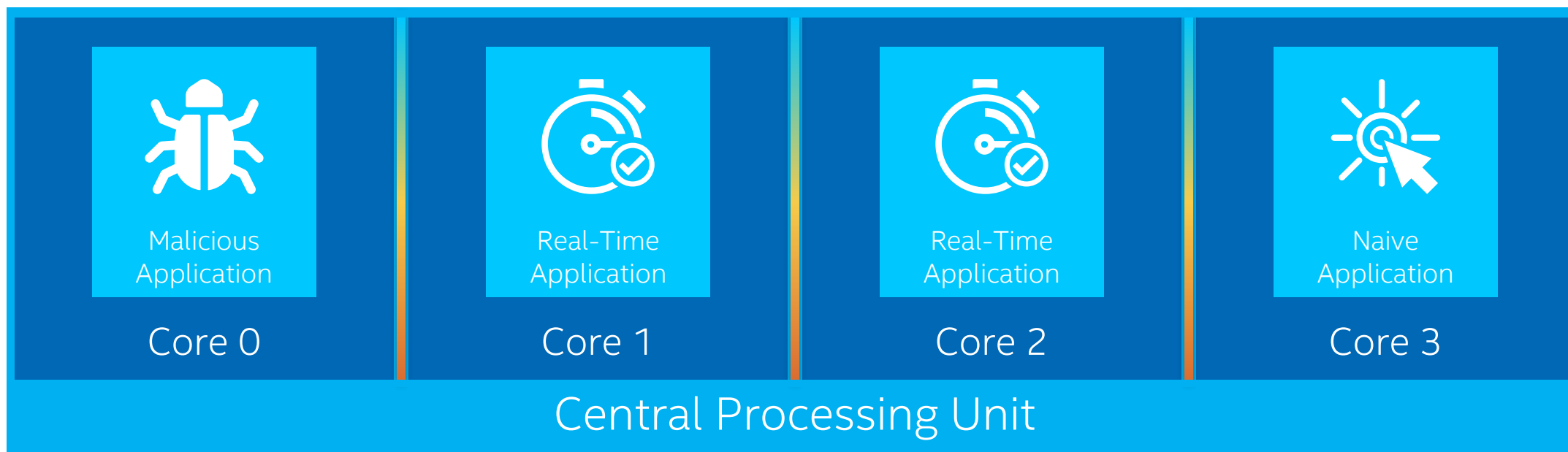
- The Always Running Timer (**ART**) is used to coordinate time across the SOC fabric
- The CPU time (**TSC**) is derived from ART:
 - $TSC = ART * CPUID[15H].EBX / CPUID[15H].EAX + K$
(See Intel Software Developer's Manual Chapter 17.17.4- Document number: 325462)
- The ART clock is extended to PCIe peripherals using Precision Time Measurement (**PTM**) Protocol
- The relation between the **Network** timestamp clock and ART (also TSC) is determined using cross-timestamp hardware; using TSN (802.1AS) the ART clock is extended outside of the platform
- The **Time-Aware GPIO** interface logic is driven by ART; edge events (one shot and pulse train) can be sampled or driven with respect to the ART clock

Intel® Time Coordinated Computing (Intel® TCC) Timeliness Hardware: Real-time Optimizations throughout the SOC



Intel® TCC Provides Temporal Isolation

Temporal Isolation protects real-time applications from the impact of other processes and events happening in the system

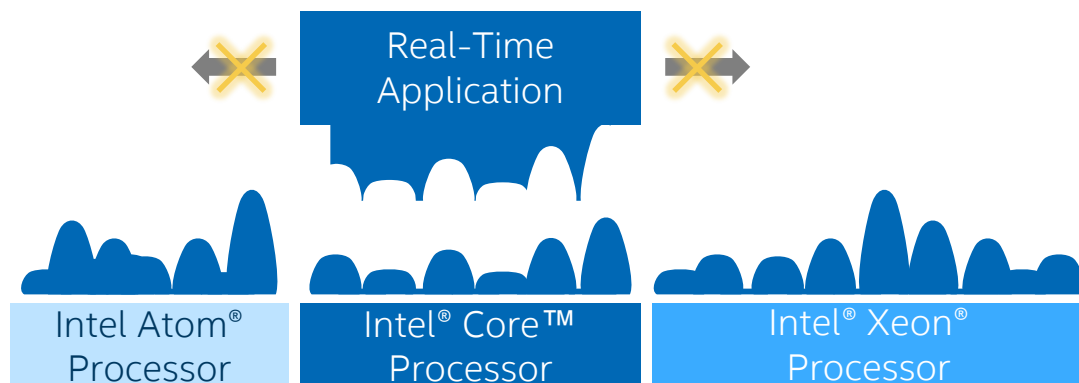


in the presence of concurrency

Intel® TCC Software Enables Portability

Temporal Portability allows applications to meet real-time requirements on different processors with minimal porting efforts

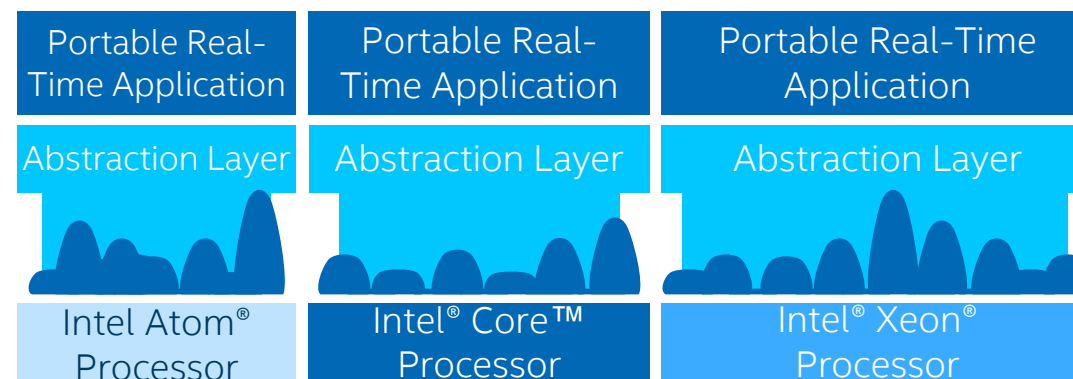
Limited Portability



Development Challenges

- In-depth real-time expertise required
- Complex and lengthy development projects
- Non-scalable product support

Temporal Portability



Software Benefits

- Simplifies and accelerates development
- Unlocks fine-grain real-time optimizations
- Supports popular software environments

Intel® Time Coordinated Computing Tools

One-Stop Shop for Real-Time Software Development Needs

Unlock the value of Intel processors' real-time capabilities with a collection of APIs, utilities, samples, and more

Real-Time Configuration & Optimization



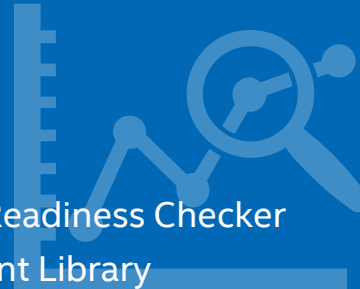
Data Streams Optimizer
Cache Configurator
Cache Allocation Library

Time Synchronization & Communication



Cross-Timestamp Sample*
Time-Aware GPIO Sample
Real-Time Communication Demo*

Measurement & Analysis



Real-Time Readiness Checker
Measurement Library

* Not part of gold release of Intel® TCC Tools

Attaining Real-Time Requirements

Without Compromising Other Performance Vectors

Recommended
industrial SKUs*



Intel Atom® x6000
Processor Series
Formerly code named Elkhart Lake



11th Generation Intel®
Core™ Processor Family
Formerly code named Tiger Lake UP3



Intel® Xeon® W-11000E
Series Processors
Formerly code named Tiger Lake H

System Software Tuning

Power
Management
Tuning

Intel® TCC
Features Tuning

Fabric Tuning

higher time determinism

Board support package
with real-time optimizations

- Real-time kernel
- Optimized drivers

1

Firmware
with real-time optimizations

- Intel® TCC Mode in BIOS
- SMI reduction

2

Intel® TCC Tools



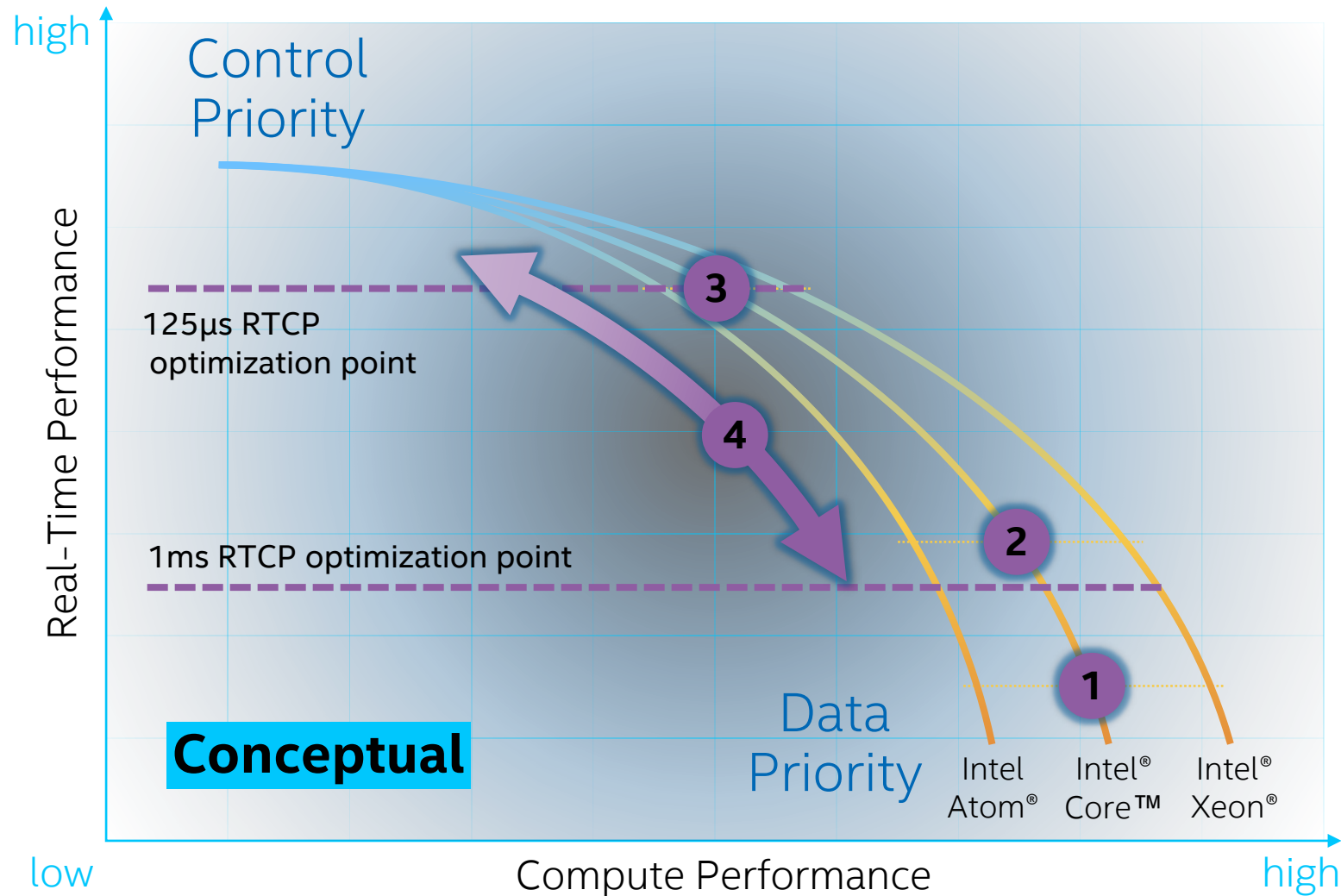
- Granular real-time tuning
- Real-time / power / general compute balance

3

*These are examples and for the full list to see [Intel® TCC Tools](#)

Attaining Real-Time Requirements

Without Compromising Other Performance Vectors



Fixed Optimization Points

(incremental)

- 1** No optimizations
 - Recommended industrial SKUs of Intel processors
- 2** Out-of-box configuration
 - Board support package with real-time optimizations
- 3** Out-of-box configuration with Intel® TCC optimizations
 - Board support package with real-time optimizations
 - Intel® TCC Mode in BIOS

Flexible Tuning

- 4** Intel® TCC Tools

Intel® TCC Resources

	Intel reference Implementation	Distribution Channels
Application	 Intel® TCC Tools	Download from Intel® TCC Tools website www.intel.com/content/www/us/en/developer/tools/time-coordinated-computing-tools/overview.html
Middleware		
RTOS Virtual Machine	Yocto Project* with real-time kernel	Download from Resource & Design Center rdc.intel.com
Hypervisor	ACRN	Download from Project ACRN website projectacrn.org
Firmware	UEFI BIOS <i>or</i> Slim Bootloader	Download from Resource & Design Center rdc.intel.com
Hardware Platform		Learn more at Resource & Design Center TGL U BSP EHL BSP

Support of Other Environments

- Intel partners with industry leaders to enable their products with Intel® TCC.
- Intel grants access to source code of reference implementation under permissive license to encourage proliferation into other environments.

Summary

Intel® TCC Value Proposition

Intel® TCC Capabilities

Intel® TCC Tools

System Tuning based on Intel® TCC



Quiz

1. Intel® TCC Investments range ().
(a) hardware platform (b) BSP (c) middleware and the application (d) all above
2. Intel® TCC is a set of features spread across multiple modules of Intel processors helping improving their real-time characteristics: Time Synchronization and Timeliness (True or False)
3. The main purpose of TGPIO is to have a precise time synchronization between devices. The Time-Aware GPIO interface logic is driven by TSC (True or False)
4. Platform power management tuning has the highest impact on real-time performance and can improve worst-case execution time (WCET) by many orders of magnitude. (True or False)
5. Intel® Time Coordinated Computing Tools has sections of tools. They are ().
(a) real-time configuration and optimization (b) time synchronization and communication
(c) measurement and analysis (d) all above

The background is a blurred industrial scene, likely a semiconductor manufacturing facility. It features various pieces of machinery, including what appears to be a robotic arm or a precision placement machine, with metallic components and some red safety elements. The lighting is bright and even, typical of a cleanroom environment. The Intel logo is centered in the foreground, with the word 'intel' in a bold, black, sans-serif font. A small blue square is positioned above the 'i'. A registered trademark symbol (®) is located to the right of the word 'intel'.

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