`

Yocto Project* based BSP with PREEMPT_RT patches and Time-Sensitive Networking (TSN) Reference Software on Intel Atom® Processor E3900 Series (formerly Apollo Lake-I)

Release Notes

April 2019

MR4rt-B-01 Release

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Revision History

Date	Revision	Description
April 2019	1.0	MR4rt-B-01 release with PREEMPT_RT patches and TSN Reference Software

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1.0   Introduction

This document provides general information on the Yocto Project* based BSP with PREEMPT_RT patches and Time-Sensitive Networking (TSN) Reference Software for Linux. This software is validated using the Intel Atom® Processor E3900 Series (formerly known as Apollo Lake-I).

This release integrates a reference software implementation and sample applications to demonstrate time synchronization and Time Sensitive Networking (TSN) Qav, and Qbv features on Apollo Lake-I Leaf Hill CRB's Yocto Project* based BSP with PREEMPT_RT patches.

1.1   Terminology

Table 1.   Terminology

Term	Description
BSP	Board Support Package
CRB	Customer Reference Board
gPTP	Generalized Precision Time Protocol
IBP	Intel Business Portal, https://businessportal.intel.com/irj/portal
IEEE 802.1Qav	Forwarding and Queuing Enhancements for Time-Sensitive Streams
IEEE 802.1Qbv	Enhancements for Scheduled Traffic
SDK	Software Development Kits
SoC	System on Chip

1.2   Reference Documents

Table 2.   Reference Documents

Document	Document No./Location
Intel Atom® Processor E3900 Series, and Intel® Pentium® and Celeron® Processor N- and J-Series (Apollo Lake) site	http://www.intel.com/content/www/us/en/embedded/products/apollo-lake/overview.html
Intel® Ethernet Controller I210 Datasheet	https://www.intel.com/content/dam/www/public/us/en/documents/datasheets/i210-ethernet-controller-datasheet.pdf
TSN Reference Software User Guide	605583

Document	Document No./Location
Intel Atom® Processor E3900 Series, and Intel® Pentium® and Celeron® Processor N- and J-Series (Apollo Lake) site	http://www.intel.com/content/www/us/en/embedded/products/apollo-lake/overview.html
Yocto Project* based BSP with PREEMPT_RT patches	https://github.com/intel/iotg-yocto-bsp-public/tree/e3900/master (check out MR4rt-B-01)
TSN Reference Software	https://github.com/intel/iotg_tsn_ref_sw

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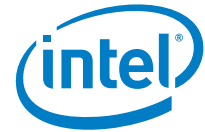
2.0   *New Features in This Release*

This section is not applicable to the current release.

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3.0 Product Features in This Release

3.1 Supported Features

3.1.1 TSN Reference Software

This release includes the following features:

- **IEEE 802.1AS:** Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks
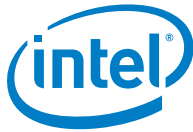   - o A reference application that demonstrates time synchronization measurement quality between the grandmaster clock and the slave clock.

- **IEEE 802.1Qav:** Forwarding and Queuing Enhancements for Time-Sensitive Streams & **IEEE 802.1Qat:** For registering and deregistering AV
    - o A reference application that demonstrates the use of the Credit-Based Shaper (CBS, IEEE 802.1Qav) and the LaunchTime feature of the Intel® Ethernet Controller I210 to ensure bounded transmission latency for time-sensitive and loss-sensitive real-time data streams.
    - o Additionally, the reference application serves as an example for using the Stream Reservation Protocol (SRP) as described in IEEE 802.1Qat for time-sensitive traffic resource management.

- **IEEE 802.1Qbv:** Enhancements for Scheduled Traffic, supported by the LaunchTime feature in the Intel® Ethernet Controller I210
    - o A reference application that demonstrates the benefits of using Time-Aware Traffic Scheduling and LaunchTime to reduce transmission jitter for scheduled traffic as measured by inter-packet latency.
    - o Inter-packet latency measures the time between packets as they are being transmitted. It also reflects how deterministic the scheduled traffic is being transmitted (within the defined cycle time).

- **OPC Unified Architecture (OPC UA)**
    - o A reference application that demonstrates the use of Time-Aware Traffic Scheduling and LaunchTime to reduce transmission jitter for an OPC UA Publishing traffic.

3.1.2   Yocto Project* Based BSP with PREEMPT_RT Patches

Supported I/O and Kernel features:

- Preempt_RT Patches

- Storage:

    o   Serial Peripheral Interface (SPI) NOR Flash

    o   Embedded Multi-Media Card (eMMC*)

    o   SD* card

    o   SATA*

    o   Universal Serial Bus (USB) 2/3 host

    o   USB device

- System:

    o   Real-time Clock (RTC)

    o   Thermal

    o   High-performance Event Timer (HPET)

    o   8253 Timer

    o   Watch Dog

- Low Power Sub-System (LPSS):

    o   Universal asynchronous receiver/transmitter (UART)/High Speed UART (HSUART)

    o   Inter-Integrated Circuit (I2C)

    o   SPI

- Memory:

    o   Error Checking and Correction (ECC)

- Power Management:

    o   S3

    o   S4

    o   S5

      o   P-state driver

- Connectivity:

      o   Gigabit Ethernet

- Miscellaneous:

      o   Low Pin Count (LPC)

      o   Peripheral Component Interconnect Express (PCIe*)

      o   System Management Bus (SMBus)

      o   General Purpose input/output (GPIO)

      o   SDIO*

      o   Pulse Width Modulation (PWM)

      o   IOSF-SB

- USB DRD software mode role switching

- LPSS SPI Programmed Input/ Output (PIO)/Direct Memory Access (DMA) transfer threshold configuration – The threshold to use PIO or DMA can be configured through the board file

Supported Audio Features

- HD Audio playbacks and records

- I2S Audio playback and records

Supported Graphics

- XFCE user interface

Yocto Project* based BSP with PREEMPT_RT Patches and TSN Reference Software for Apollo Lake-I
Release Notes   April 2019
10   Document Number: 611026 Revision 1.0

3.2   Unsupported Features

- S0ix Power Management and Telemetry Driver

- Intel® Media SDK

- Intel® ISP Firmware and Driver

- Intel® Integrated Sensor Solution Utility

- Intel® System Studio

- Secure boot

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4.0 *Known Issues*
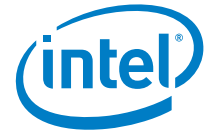
Defect ID	Description
1507048087	White display in extended mode.

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5.0   *Fixed Issues*

This section is not applicable to the current release.

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6.0 Limitations

The results listed in the TSN Reference Software User Guide (RDC # 605583) may not be identically reproduced as inter-packet latency is very sensitive and may vary due to the duration of the test as well the current health and state of the platform.

Software daemons, such as ptp4l (linuxptp) and gPTP daemon (OpenAvnu) drive network time synchronization. This helps gain accuracy in sub-microseconds through hardware time-stamping on all PTP message exchanges at the network controller. The governing rules within these daemons ensure the time synchronization and clock synchronization processes are performed within acceptable time synchronization accuracy conditions at the slave clock.

A busy network, a heavily loaded CPU, or with other external factors such temperature rise, transmission, or clock jitter at the network switch can see deterioration of time synchronization. The quality of time synchronization can deteriorate to such an extent that eventually leads to the process being restarted by the time synchronization daemons.

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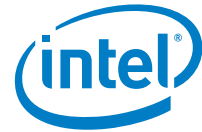
7.0 *Release Content*

- Yocto Project* –based BSP with PREEMPT_RT patches (https://github.com/intel/iotg-yocto-bsp-public/tree/e3900/master)

- TSN Reference Software for Linux* (https://github.com/intel/iotg_tsn_ref_sw)

- TSN Reference Software User Guide: Zip file in HTML and PDF format

- Release Notes (this document)

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