WIRELESS IOT

CONTENT LIST

Ceva-Waves™ Links

Family of innovative multi-protocol wireless platform IPs integrating Wi-Fi, Bluetooth, IEEE 802.15.4 (for Thread/ Matter and Zigbee) and Ultra-Wideband (UWB), to accelerate the development of connected Smart Edge SoCs.

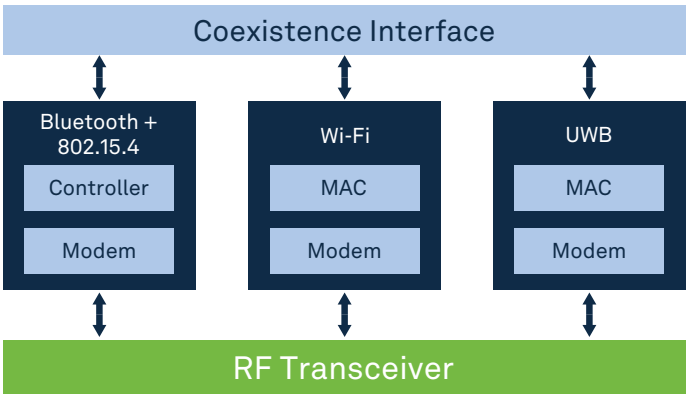
Product Features

- Highly versatile multi-protocol wireless connectivity platform, leveraging the latest Ceva-Waves IPs, including:
  - Extensive range of Wi-Fi configurations spanning from low power Wi-Fi 6 1x1 20/40Mhz 2.4GHz single band for IoT, up to advanced Wi-Fi 7 2x2 160MHz triple band with MLO support
  - Bluetooth LE or Bluetooth Dual Mode support, from basic IoT configuration up to advanced implementations supporting the latest Bluetooth innovations, including AoA/AoD, Classic and LE Audio with Auracast, PAwR and Channel Sounding
  - IEEE 802.15.4 for Thread/Matter and Zigbee support for smart home applications
  - Ultra Wide Band (IEEE 802.15.4z/ HRP), with FiRa 2.0, CCC Digital Key 3.0, and Radar for micro-location and sensing features
- Optimized co-existence schemes for each specific configuration
- Pre-integrated radio solutions, including RF from Ceva, various partners, and customer's own in-house developments, addressing a wide range of configurations and foundry process nodes
- Hardware-accelerated embedded security modes and encryption to fully comply with the most demanding wireless standard specifications
- Complemented by Ceva's extensive IP portfolio of Edge AI NPUs, audio, voice and sensing solutions

Introduction:

Ceva-Waves Links is a versatile family of multi-protocol wireless platform IPs, encompassing the latest consumer wireless standards. It leverages the industry-leading Ceva-Waves Wi-Fi, Bluetooth, IEEE 802.15.4 (for Thread / Matter and Zigbee) and Ultra-Wideband (UWB) IPs to offer integration-friendly wireless solutions to accelerate the development of connectivity-rich SoCs. With its modular architecture, coupled with Ceva's extensive experience in wireless systems, Ceva-Waves Links can deliver tailored solutions to address application-specific requirements. Each wireless protocol is supported through optimized hardware platforms for lowest power, accompanied by comprehensive software frameworks executing on the embedded processors, all designed for seamless integration with the RF.

Ceva-Waves Links



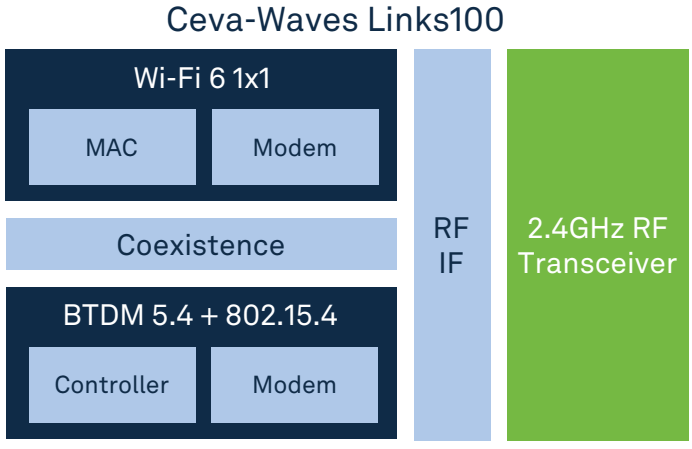
IP Deliverables

- RTL package for an integration-friendly turnkey hardware platform, embedding the required mix of Wi-Fi, Bluetooth, IEEE 802.15.4 (for Thread / Matter and Zigbee) and Ultra-Wideband (UWB) protocols from the Ceva-Waves portfolio.
- Comprehensive C code packages for each wireless protocol, including advanced sensing and location algorithms for Bluetooth Channel Sounding, Wi-Fi CSI, and UWB Radar.

IP Packages Available

The first member of the Ceva-Waves Links family, the Links100, is an integrated, low power, Wi-Fi / Bluetooth / 802.15.4 communications subsystem IP for IoT applications, with the following key features:

- Wi-Fi 6 1x1 40MHz optimized for cost-sensitive IoT applications
- Bluetooth 5.4 Dual Mode, supporting advanced Classic Audio and LE Audio with Auracast, and available with a comprehensive suite of Bluetooth profiles
- IEEE 802.15.4 (for Thread/Matter and ZigBee) for smart home and IoT applications
- Optimized co-existence scheme for efficient concurrent communications
- Pre-integrated with a low power multi-protocol 2.4GHz radio in TSMC 22nm process



Demonstration Platform:

A XILINX FPGA based Prototyping platform containing Ceva-Waves Links100 hardware platform and RF daughter board is available. Running at real speed, it can be used for:

- HW & SW prototyping and debug
- Pre-silicon application software development
- Interoperability testing against 3rd party wireless connectivity solutions
- Certification / Qualification
- System demonstration

Contact Ceva for information on other upcoming Links members, or to discuss a tailored solution for your needs, from optimized IoT applications to high performance data streaming applications powered by Wi-Fi 7.

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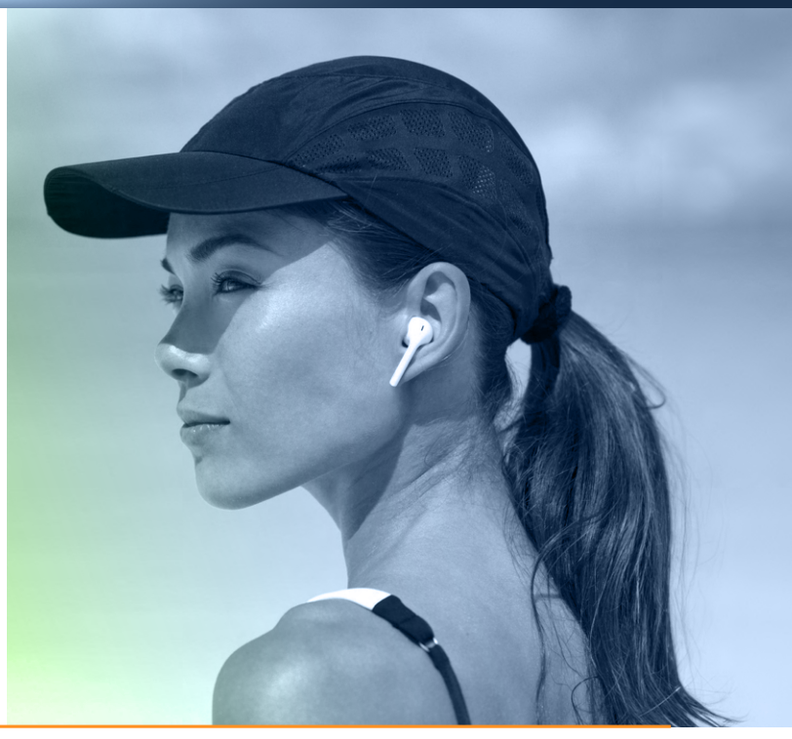
For more information:

Ceva-Waves™

PRODUCT NOTE

Ceva-Waves™ Bluetooth

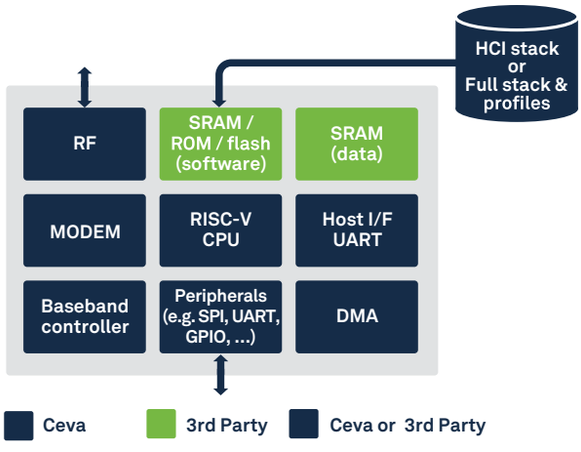


Comprehensive set of Bluetooth Low Energy and Bluetooth dual mode Silicon Intellectual Properties and software for consumer, automotive and IoT devices, with latest generation features including LE Audio / Auracast, PaWR and Channel Sounding

Key Benefits

- Comprehensive IP supporting the latest versions of
  - Bluetooth Low Energy
  - Bluetooth dual mode
- Consists of hardware baseband controller plus RF/ modem block, coupled with software protocol stack Flexible RF interface for deployment with alternative radios
- Agnostic to embedded processor and operating system, with portable source code software stacks and an AMBA® AHB interface from hardware baseband controller
- Reference integrated platform with embedded RISC-V CPU also available
- Designed for minimum die area and power, with low gate count, low memory footprint and low MIPS requirement
- Optional add-on for 802.15.4 support (with Ceva-Waves 15.4 MAC and modem), compliant with Zigbee, Thread and Matter requirements
- Complemented by Ceva-Waves 802.11a/b/g/n/ac/ax (Wi-Fi 4/5/6) IPs for consumer, industrial and IoT combos
- Complemented by Ceva-Waves UWB IP, compliant with FiRa and CCC, for secure ranging and higher datarate transfer

Target Markets



Example of RivieraWaves Bluetooth Cip Implementation

The Ceva-Waves Bluetooth IP family offers a comprehensive suite of products for embedding Bluetooth connectivity into SoCs/ASSPs, with optimised solutions for both Bluetooth Low Energy (LE) and dual mode configurations.

The Ceva-Waves Bluetooth products incorporate a hardware baseband controller coupled with a software stack and an optional RF/modem block. In addition, Ceva has multiple RF partners to help address deployment on various foundries and process nodes; RF partners include CSEM, Aura Semi, Sirius Wireless and others.

The software stack is easily portable to customer's choice of embedded processor, such as the ARM® Cortex-M™ family, ARC® EM family, AndesCore™ family, RISC-V processor, Ceva DSP and others.

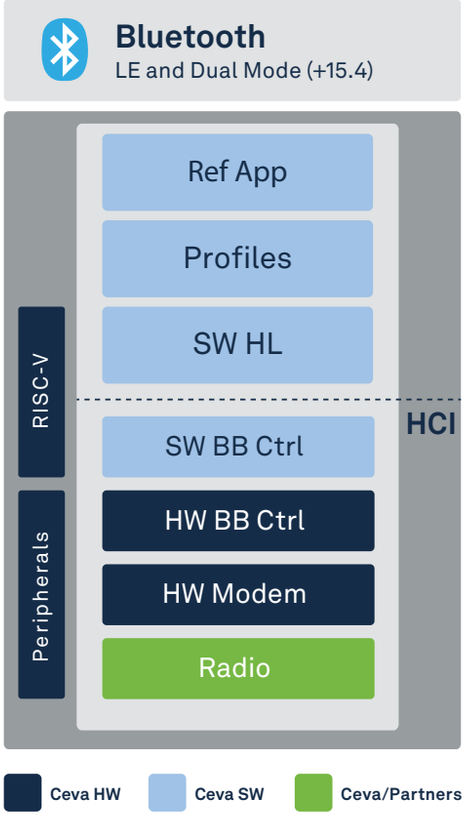
An optional cost effective fully integrated reference platform is also available to speed up SoC design and minimize time to market. This platform is provided with a RISC-V processor, relieving customers from the need to license a 3rd party commercial processor.

The Bluetooth IPs are provided with an optional FPGA platform plus a comprehensive GUI validation tool for manual testing and automatic execution of test scripts for laboratory testing.

With the Ceva-Waves family of wireless connectivity IP, Ceva is the only IP provider offering a complete suite of Bluetooth IPs, 802.15.4 IP, UWB IPs, NB-IoT IP, GNSS IP and a wide portfolio of Wi-Fi (802.11a /b / g/ n/ ac/ ax IPs.)

This comprehensive suite of wireless connectivity IP is complemented by Ceva's extensive portfolio of audio/ voice solutions and Always-On sensor hub solutions, based around the Ceva DSP core family.

Further, to accelerate the design of Bluetooth Audio SoCs, Ceva also offers Bluebud™, a turnkey fully integrated hardware and software platform optimized for smartwatch, earbud, headset, speaker and other audio peripherals. Built around the Ceva-BX1 processor, it includes a Bluetooth dual mode baseband controller and protocol stack with a extensive list of profiles including Classic Audio and LE Audio profiles, a long list of audio CODECs, an optimized TWS left/right synchronisation mechanism



Ceva-Waves Bluetooth Low Energy

Key Features

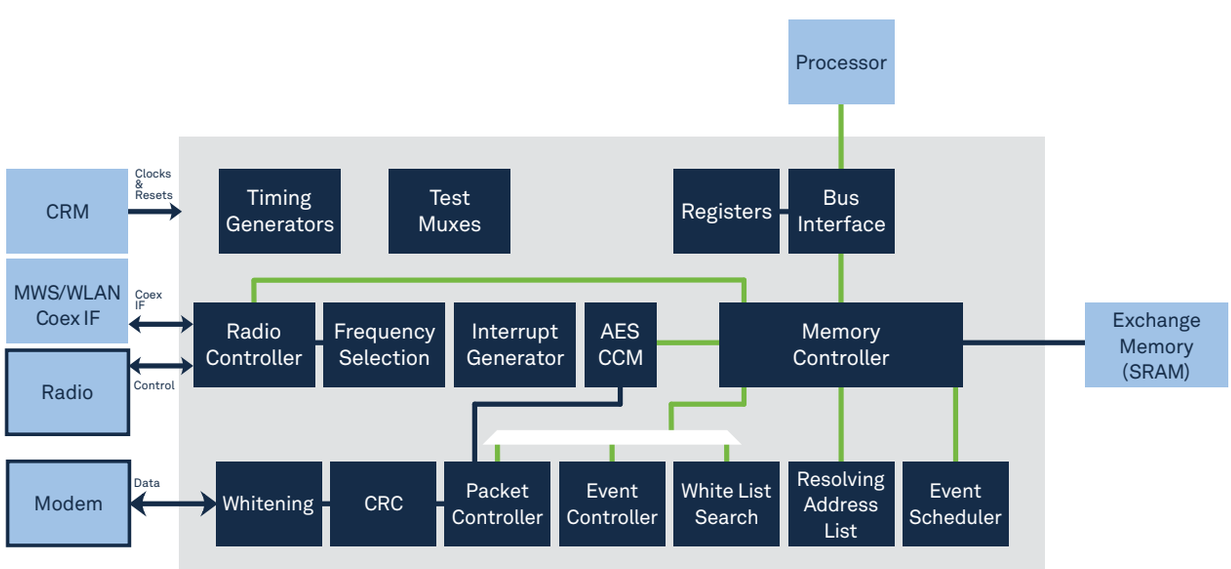
- Comprehensive support of the latest version of Bluetooth LE specifications (v5.4), 2Mbps, Long Range, Direction Finding (AoA/AoD), Isochronous / LE Audio, Packet Advertising with Response, and Channel Sounding.
- Supports advanced master and slave topologies
- Comprehensive software stack spanning all protocol layers: HCI, L2CAP, ATT, SMP, GAP, GATT
- Extensive list of Profiles:
  - Medical/ HealthCare: Blood Pressure, Health Thermometer, Glucose / Continuous Glucose Monitor, Weight Scale, etc
  - Sport & Fitness : Cycling & Running Speed, Cycling Power, Heart Rate
  - Audio: Full Generic Audio Framework (GAF) for LE Audio including Auracast™ receiver and transmitter; Apple MFi LEA
  - Mesh, with Lighting and Generic Models
  - Miscellaneous: Alert Notification, Phone Alert Status, HID, Environmental Sensing, Location and Navigation, etc
- Optional support for 802. 15.4 (for ZigBee, Thread, Matter)
- Extremely low power design, permitting local embedded processor to operate with a clock of only 8MHz in active connections Frequency Hopping with channel assessment for higher link robustness and devices improved coexistence with interferers such as WLAN devices

The Ceva-Waves Bluetooth Low Energy IP is a very low power, low MIPs & low gate count solution, ideally suited for a wide range of IoT applications including smartwatches, wearable sensors for medical /sports (heart rate, glucose, temperature), audio applications such as True Wireless Stereo earbuds and hearing aid instruments, remote controls, PC peripherals, toys, environment sensors, location beacons and many other machine–machine communications.

Compatible with the latest version of the Bluetooth LE specifications, the Bluetooth Low Energy IP consists of a hardware baseband controller coupled with a complete software stack including a comprehensive list of services and profiles.

The hardware baseband controller is provided as a Verilog IP package. It performs packet encoding/decoding and frame scheduling and is complemented by an embedded hardware AES128 encryption engine. Additional crypto engines are available as an option.

The software stack is provided as a C code IP package. It consists of Link Layer (LL), L2CAP, ATT, SMP, GAP/GATT services and profiles.



Ceva-Waves Bluetooth Dual Mode

Key Features

- Comprehensive support of the latest version of the Bluetooth dual mode specifications, including Bluetooth Classic along with hallmark features of the Bluetooth LE specifications, including 2Mbps, Long Range, Direction Finding (AoA/AoD), Isochronous Channels / LE Audio, Packet Advertising with Response, and Channel Sounding
- Supports enhanced dual mode topologies
- Extended co-existence features for WLAN & LTE environments, including Mobile Wireless Service (MWS) Coexistence Signaling and Train Nudging
- SCO & eSCO voice support with dedicated hardware, supporting CVSD, A/u law and PCM interface
- Frequency Hopping with channel assessment for higher link robustness and improved coexistence with interferers such as WLAN devices
- Optional support for 802.15.4 (for ZigBee, Thread, Matter)
- Host protocol stack with extensive list of profiles, with simultaneous support of Classic Audio and LE Audio, including Auracast compliance

Overview

The Ceva-Waves Bluetooth dual mode IP incorporates Bluetooth Classic & Bluetooth Low Energy. It provides an optimised solution for next generation 'combo' SoCs for cellular phones, tablets, smart speakers, audio accessories and other products.

Backward compatible with earlier versions of the Bluetooth standard, the latest Bluetooth dual mode IP consists of a hardware baseband controller coupled with a full software stack with profiles, and an optional modem+RF transceiver.

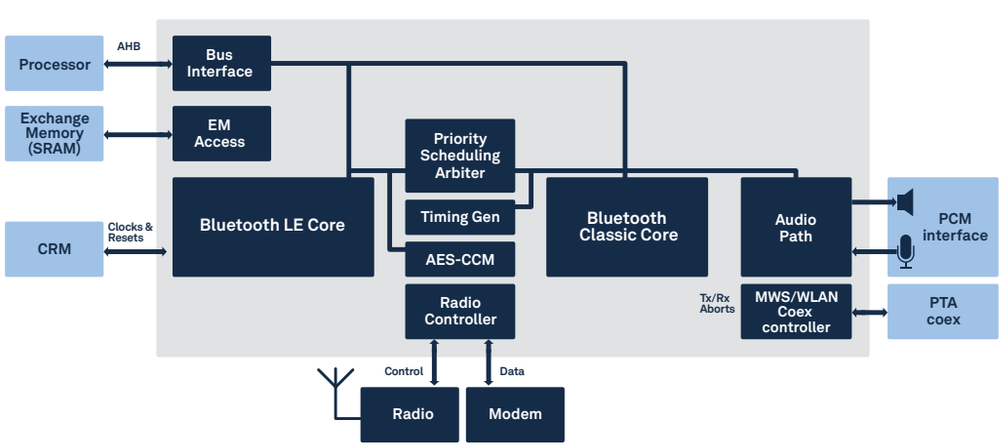
The standard HCI interface ensures that the Bluetooth dual mode IP can be used with the Ceva-Waves Bluetooth dual mode host protocol stack and profiles, or with compliant Host software stack (and profiles), including BlueDroid™ (as per Android™), BlueZ™ and others.

The Hardware Baseband Controller is provided as a Verilog IP package. It performs packet encoding/decoding and frame scheduling for both Bluetooth Classic and Bluetooth LE. It is complemented by a CVSD hardware codec with a-law/u-law/linear PCM samples converter for voice applications.

The Controller Software Stack is provided as a C code IP package. It is composed of the LE Link Layer (LL), Classic Link Controller (LC), Classic Link Manager (LM) and Host Control Interface (HCI).

The host stack, also provided in source code, includes the A2DP, HFP, AVRCP and SPP profiles and all the LE profiles available in the Ceva-Waves Bluetooth Low Energy stack.

The Modem+RF Transceivers are available in various process nodes and are designed for easy integration into digital SoC. The digital portion (modem and RF controller) is provided as RTL IP package. The analogue portion (ADC/ DAC, PLL, LNA, PA, mixer, LDO, ...) is available as a GDSII IP package.



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For more information:

Ceva-Waves™ Wi-Fi

Innovative set of tailored Wi-Fi 4 (802.11a/b/g/n), Wi-Fi 5 (802.11ac), Wi-Fi 6/6E (802.11ax) and Wi-Fi 7 (802.11be) MAC and Modem Intellectual Properties composed of hardware and software for easy integration into SoCs, from 1x1 up to MIMO 2x2, for Stations and Access Points.

Product Features

- **Comprehensive Wi-Fi IP family consisting** of a set of MAC and modems IPs and platforms compliant with Wi-Fi 4 (802.11a/b/g/n), Wi-Fi 5 (802.11ac), Wi-Fi 6/6E (802.11ax) and Wi-Fi 7 (802.11be) tailored for various applications including IoT, wearable, mobile and access points
- **Industry's smallest and most power efficient Wi-Fi** IPs and platforms
- **Supports AP, STA & Wi-Fi Direct modes of operation**
- **Security modes:** WEP, WPA, WPA2, WPA3, WPS
- **Hardware encryption:** TKIP, RC4, AES128, SMS4
- **Quality of Service:** WMM, WMM-PS
- **Scalable MAC supporting** any throughput from a few Mbps (802.11n 1x1) up to multi Gbps (802.11be 2x2)
- **FullMAC and fully hosted software stacks**
- **Comprehensive choice of tailored modems:**
  - 20/40/80/160 MHz bandwidths support
  - From 802.11n 1x1 up to 802.11be 2x2
  - Hardwired implementation for lowest power consumption and smallest size
- **STBC**
- **Beam Forming both as a transmitter and as a receiver**
- **All MCS up to 1KQAM (Wi-Fi 6/6E) and 4K QAM (Wi-Fi 7)**
- **All guard intervals**
- **MU-OFDMA/MIMO as a STA and as an AP**
- **A-MPDU & A-MSDU frames aggregation**
- **Block acknowledgement**
- **Various optional features available:**
  WAPI (with hardwired SMS4 encryption engine), LDPC, MU-MIMO (as STA and as AP), mesh, radar detection mechanism (DFS), ML decoder
- **Bluetooth coexistence interface**
- **Support of EasyMesh for access points**
- **Support of RSDB (Real Simultaneous Dual Band)**
- **Support of MLO and MRU for Wi-Fi 7 Power Down and Sleep** modes implemented in Hardware and Software
- **Reference digital front end**, radio controller and AGC/ CCA software defined state machine for use with Wi-Fi radios from various RF partners

Introduction

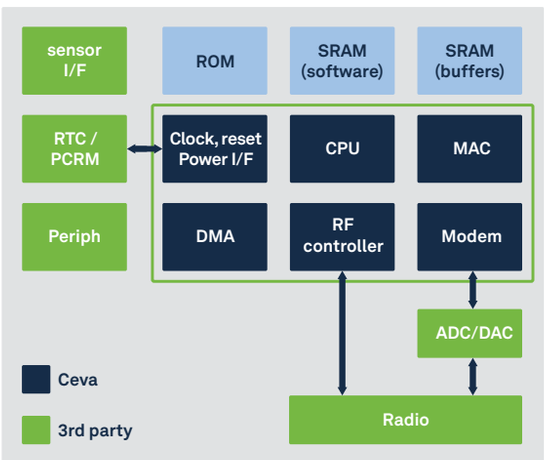
The Ceva-Waves Wi-Fi IP family offers a comprehensive Suite of IPs and platforms for embedding Wi-Fi connectivity into SoCs/ASSPs Optimized implementations are available for various applications, from low power IoT peripherals right up to high performance, multi-user gateways and spanning all flavours of 802.11a/b/n/ac/be.

Each Ceva-Waves Wi-Fi solution incorporates hardwired PHY modem functions and MAC functions, including a Full MAC software protocol stacks. A fully hosted stack is also proposed, comprising the integration of FullMAC stack in FreeRTOS along with TCP/IP, supplicant and a reference IoT application. Designed for flexibility, the Ceva-Waves Wi-Fi IPs can support several RFs in various foundries and process nodes from RF partners such as Sasken, Sirius Wireless, Sabertek and others. The MAC software stack is easily portable to customer's choice of embedded processor, such as Ceva DSP, ARM® Cortex™ family, ARC® EM family, AndesCore™ family, RISC-V and others. The IP is provided with an integration-ready processor and operating-system - agnostic platform, simplifying deployment in SoC/ASSP designs.

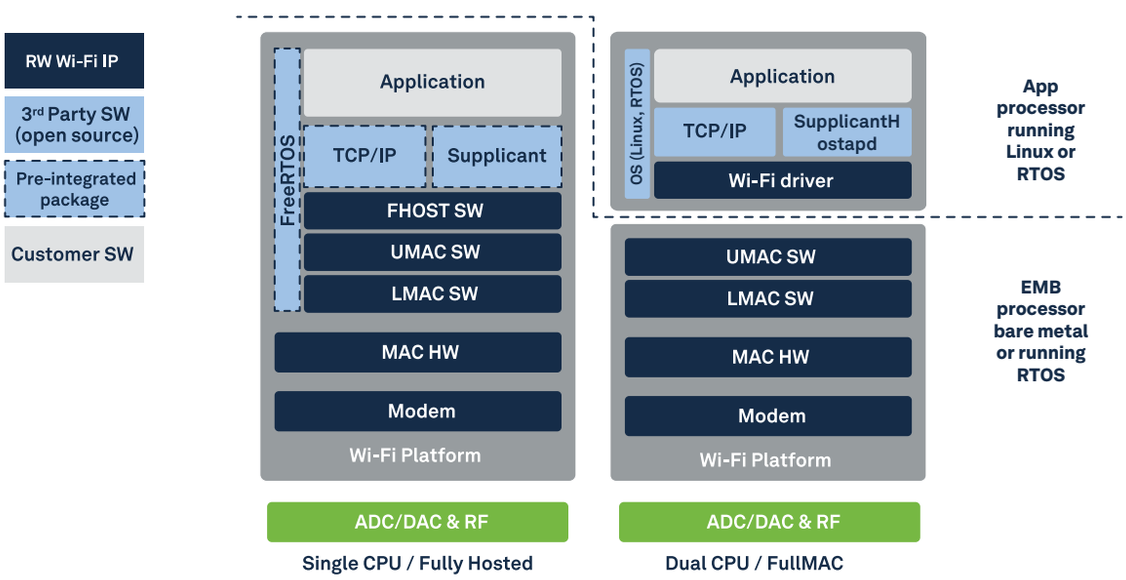
IP deliverables

- RTL package for a turnkey hardware platform embedding the Ceva-Waves Wi-Fi hardware MAC and modems, peripherals and RISC-V processor
- C code packages for Ceva-Waves Wi-Fi MAC software protocol stacks (fullMAC, fully hosted)

Single CPU standalone Wi-Fi Chip



Ceva-Waves Wi-Fi HW+SW Architecture



IP Packages Available

The Ceva-Waves Wi-Fi IP family addresses a broad range of applications and contains a suite of solutions, each optimized for various target products, with a range of configurations. The Wi-Fi family is organized into 3 categories:

Wi-Fi IoT STA: the industry's smallest footprint and lowest power Wi-Fi IPs targeted at IoT peripherals, including wearables, medical devices, wireless audio and other use cases where power and cost are critical factors. This category includes the RW-N 802.11n 1x1 (Wi-Fi 4) compliant and RW-AX 802.11ax 1x1 (Wi-Fi 6) 20/40 MHz STA compliant IPs. It consists of a hardware MAC accelerator with a FullMAC and Fully hosted software protocol stacks, provided with a hardwired, small and low power modem.

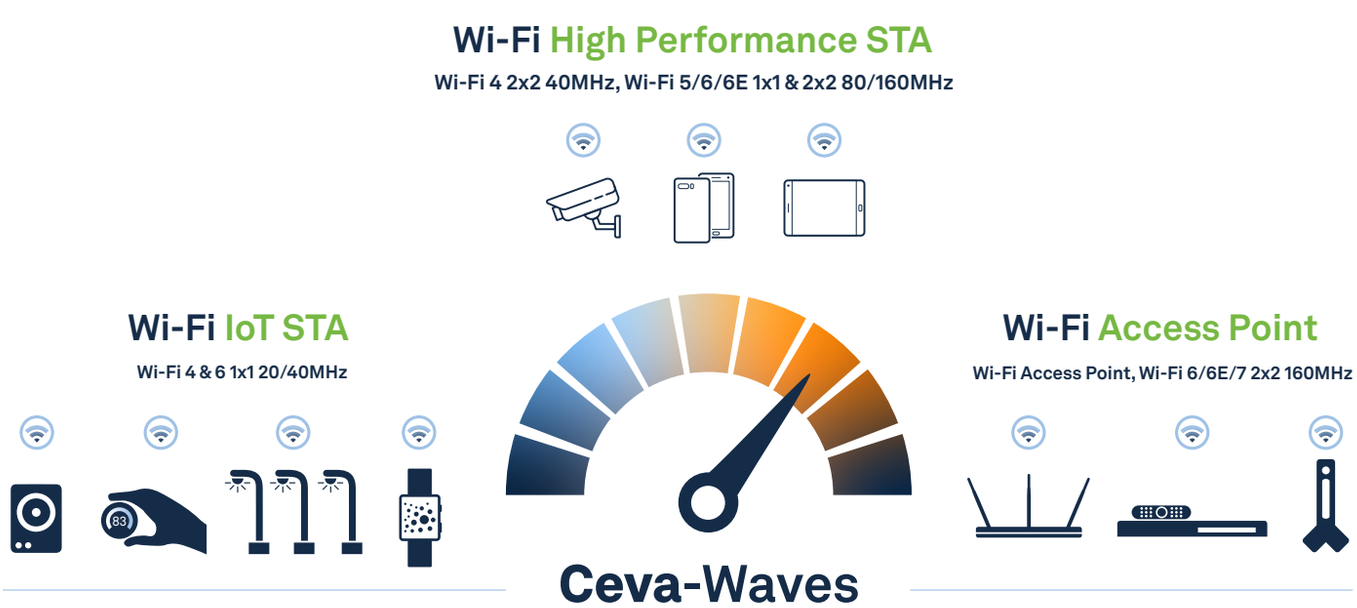
Wi-Fi High Performance STA: the industry's smallest footprint and lowest power but high performance Wi-Fi IPs comprised of RW-N 802.11n 2x2 40MHz (Wi-Fi 4), RW-AC 802.11ac 1x1 & 2x2 (Wi-Fi 5) and RW-AX 802.11ax 1x1 & 2x2 80/160MHz (Wi-Fi 6 /6E). They are aimed at the vast array of media-sharing consumer devices including smartphones, tablets, TV, STB, AR/VR headsets, cameras and smart home products. It consists of a hardware MAC accelerator with FullMAC software protocol stack, provided with either SISO or 2x2 MIMO hardwired, small and low power modem.

Combining two Wi-Fi IPs together enables the support of Real Simultaneous Dual Band (RSDB) configurations for higher throughput and lower latency.

Wi-Fi Access Points: highest performance Wi-Fi IPs consisting of the RW-AX 802.11ax 2x2 160MHz (Wi-Fi 6/6E) and RW-BE 802.11be 2x2 160MHz (Wi-Fi 7).

They address the most demanding central gateway type applications which require premium performance for large numbers of subscribers such as access points, media gateways and Wi-Fi offload in small cells. Combining two Wi-Fi IPs together enables the support of Real Simultaneous Dual Band (RSDB) access points configurations for higher throughput and lower latency. The Wi-Fi 7 version supports Multi Link Operiation (MLO) with 1, 2 or 3 links configurations.

The Ceva-Waves Wi-Fi IPs can be complemented by any of the Ceva-Waves Bluetooth and UWB IPs for total combo solutions, and by Ceva's extensive portfolio of audio/voice solutions and Always-On sensor hub solutions, based around a Ceva DSP core.



Ceva-Waves Wi-Fi Family Features & Options

	IoT STA				High Performance STA				Access Point	
	Wi-Fi 4 1x1		Wi-Fi 6 1x1		Wi-Fi 4 2x2		Wi-Fi 6 1x1	Wi-Fi 6/6E 2x2	Wi-Fi 7 2x2	Wi-Fi 6/6E 2x2 Multi 2x2 =~4x4	Wi-Fi 7 2x2 Multi 2x2 =~4x4
802.11 versions	a/b/g/n		a/b/g/n/ax		a/b/g/n		a/b/g/n/ac/ax	a/b/g/n/ac/ax	a/b/g/n/ac/ax/be	a/b/g/n/ac/ax	a/b/g/n/ac/ax/be
Bandwidth (MHz)	20	40	20	40	20	40	Up to 80	Up to 160	Up to 160	Up to 160	Up to 160
Max throughput (Mbps)	72	150	114	229	150	300	600	80: 1,200 160: 2,400	2,880	5/6: 2,400 2.4+5/6: 2,900 5+6: 4,800	5/6: 2,880 2.4+5/6: 3,380 5+6: 5,760
Features	• STA, AP and Wi-Fi Direct Modes supported concurrently • Security (WEP/WPA/WPA2/WPA3/WPS), Quality of Service (WMM, WMM-PS) • STBC (11n/ac/ax) • Beamforming (11ac/ax/be) • 11ax: OFDMA DL/UL, TWT, Buffer Report, Two NAV operation, Spatial Reuse, Multi-BSSID, Agile Multiband • 11be: MLO, MRU, STR, NSTR, MLSR										
Options	• WAPI, LDPC, MU-MIMO (ac/ax only), GCMP (ax only), mesh (802.11s), Fully Hosted software package										

Demonstration Platform

- **A XILINX FPGA based Prototyping platform containing Ceva-Waves MAC, modem and RF daughter board is available. Running at real speed, it can be used for:**
  - HW & SW prototyping and debug
  - Pre-silicon application software development
  - Interoperability testing against 3rd party Wi-Fi solution
  - Certification
  - System demonstration

Ceva-Waves Wi-Fi IP validation platform

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For more information:

Ceva-Waves UWB IP

Precision Location and Sensing for the Next Generation

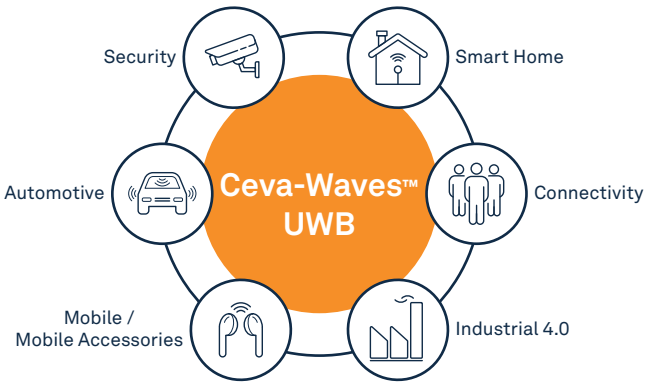
The Ceva-Waves UWB IP is a cutting-edge, low-power ultra wideband (UWB) solution designed to power innovative applications across mobile, automotive, consumer, and IoT markets. This IP delivers a complete UWB baseband PHY and MAC implementation with a focus on flexibility, efficiency, and security. It provides robust, highly accurate location and radar sensing capabilities, empowering advancements across various industries. The Ceva-Waves UWB IP enables the shortest path for designing UWB solutions across different segments.

Key Benefits:

- **Innovative & Efficient Design:** Built upon an innovative UWB baseband PHY architecture, optimizing for area and power efficiency.
- **Superior Performance:** State-of-the-art coherent receiver ensures superior sensitivity and performance, even in challenging non-line-of-sight (NLoS) conditions.
- **Advanced Algorithms:** Ranging and AoA algorithms are optimized for real-life scenarios, with software post-processing for differentiation. Advanced security algorithms are designed to counter known and emerging threats.
- **Powerful Wi-Fi Interference Cancellation:** Innovative interference suppression mechanism effectively mitigating the challenges of Wi-Fi 6E/7 interference, preventing false packet detection, and minimizing ranging performance degradation.
- **Power Optimized:** Unique packet detection mode minimizes power consumption, and low-power modes design for extended battery life.
- **Standards-Compliant & Future-Proof:** Fully compliant with IEEE 802.15.4z/ab, FiRa, and CCC Digital Key, ensuring interoperability and seamless adoption in multi-mode systems.
- **Versatile Applications:** Ideally suited for automotive digital keys, asset tracking, smart homes, consumer devices, and secure tap-free payment systems.

Target Applications:

- **Automotive:** Secure digital keys, in-cabin Child Presence Detection (CPD), driver monitoring.
- **Consumer Electronics:** Power-saving presence detection in laptops, TVs, and smart home devices.
- **Industrial and IoT:** Asset tracking, real-time location services (RTLS), gesture-based control interfaces.
- **Payments:** Secure and convenient tap-free payment solutions.

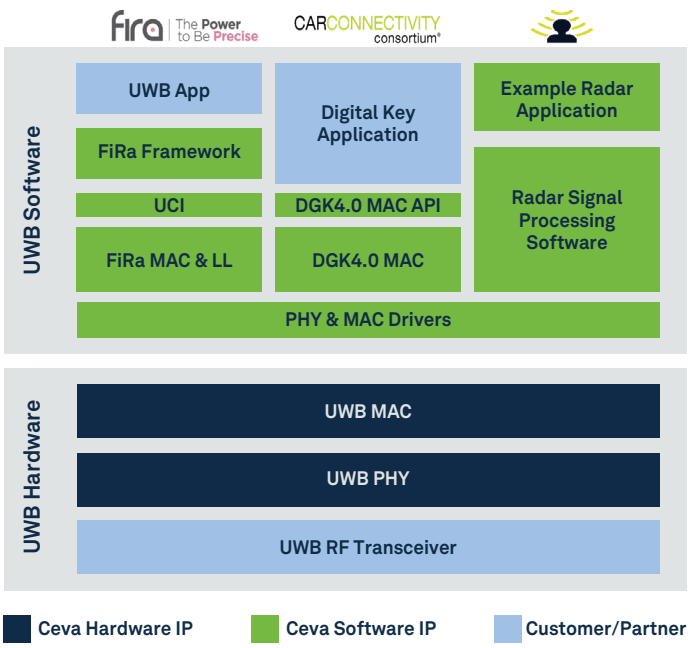


Deliverables:

The Ceva-Waves UWB IP includes the following comprehensive deliverables:

- Hardware:
  - Complete PHY & MAC Synthesizable Verilog source code, fully compliant with 802.15.4-2020 and 4z/ab operation.
  - Simulation Environment: RTL Simulation test bench for UWB Hardware IP, including UVM random environment and direct test cases.
  - Bit-exact MATLAB model of the PHY.

- Software:
  - FiRa MAC, Link Layer and UCI, Digital Key 4.0, and RADAR reference design.
  - Unit test environment with over 15,000 tests (including ranging, AoA, security, CCC session management, etc.) and cycle count infrastructure.
  - Reference workspaces for Eclipse (RISC-V, ARM), Ceva Toolbox, and VS (PC Build).
  - Code provided as pure ANSI-C, compiled for ARM families, RISC-V, Ceva-BX1 and NeuPro-Nano, and x86.
  - Automotive quality: checked for MISRA-C, CERT-C & Coverity main checkers
  - Comprehensive development environment and tools.
    - FPGA reference project running at speed.
    - Advanced control, logging, and debug tool including UCI parser, graphical interface, and SCPI.
    - UWB-Maestro test engine with unique test cases, including Digital Key test and FiRa cases.



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For more information:

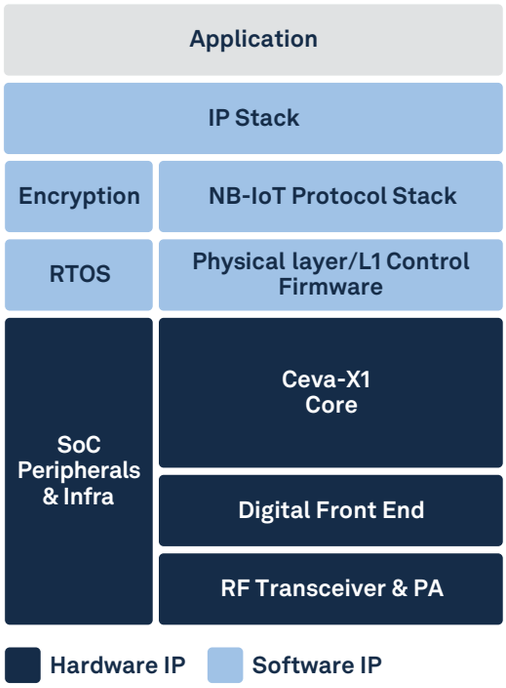
Ceva-Waves™ Dragonfly

Turnkey NB-IoT Release 14 IP solution with multi constellation GNSS support for IoT devices

The Ceva-Dragonfly NB2 pre-integrates together a Ceva-X1 processor, an optimized RF, a baseband, and a protocol stack to offer a complete Release 14 Cat-NB2 modem IP solution that reduces time-to-market and lowers entry barriers.

Ceva-Waves Dragonfly is a fully software configurable solution that can extend seamlessly with GNSS and sensor fusion functionality. It includes a reference silicon of the complete modem design, including an embedded CMOS RF transceiver, an advanced digital front-end, physical layer firmware, and a protocol stack (MAC, RLC, PDCP, RRC, and NAS).

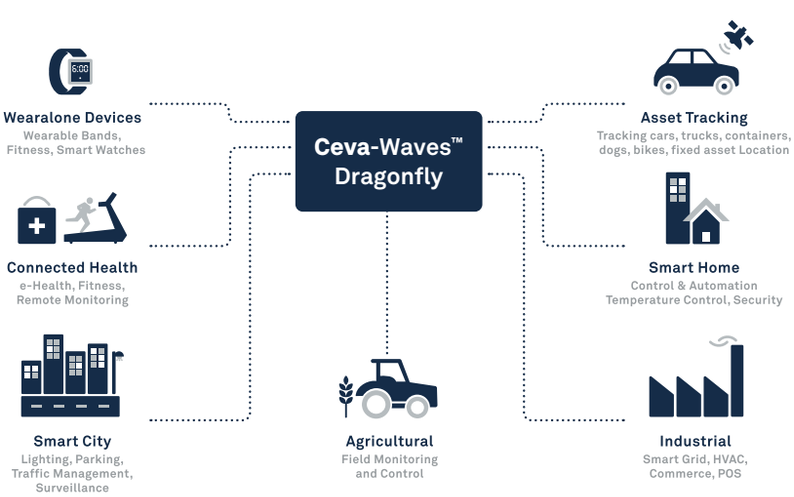
Ceva-Waves™ Dragonfly Hardware and Software components



Key Benefits

- **Reduces time-to-market** with fully integrated reference silicon and FPGA, that enables real-time, over the air, system and software development in parallel with SoC development
- **Reduces total system cost** with single processor solution for baseband, protocol and application
- **Reduces power** for >10 years operation on a single AA battery using dedicated NB-IoT and GNSS instructions
- **Single-processor, software - configurable** solution is guaranteed futureproof for NB-IoT modem and GNSS receiver upgrades
- **Software based modems** ease development cycle, accelerate time-to-market, enable product differentiation
- **Ensure** >10 years of future-proofing with in-field over the air upgrades
- **Release 15 ready** hardware can support 3GPP Release 15 with software upgrade

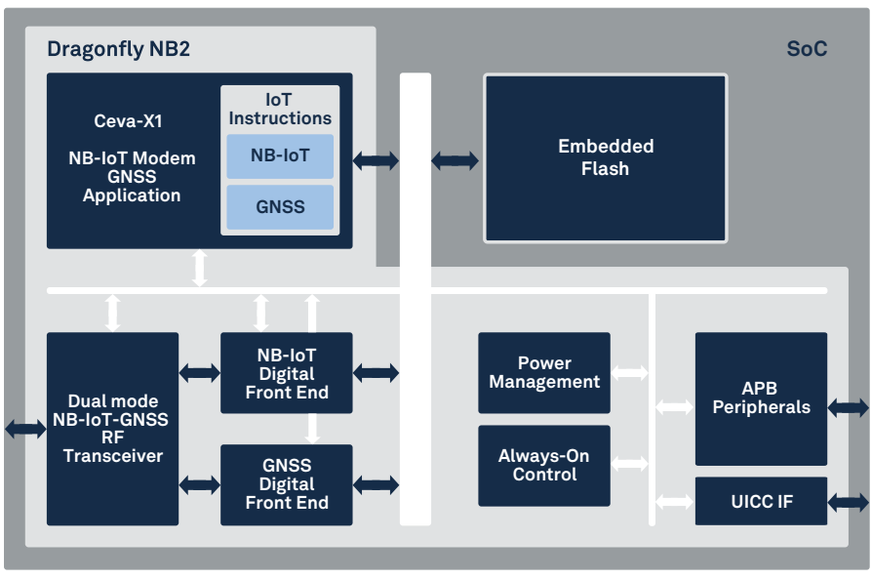
Target Markets



Main Features

- **Software components:**
  - NB-IoT Release 14 UE protocol stack
  - NB-IoT Release 14 L1 control and physical layer (PHY)
  - RTOS & drivers
  - Production and analysis tools
- **Hardware components:**
  - NB-IoT and GNSS Digital front-ends
  - Ceva-X1 processor with NB-IoT and GNSS dedicated instructions
  - SoC Infrastructure and Peripherals RF transceiver: analog and RF embedded CMOS RF transceiver, LNA, PA, DC-DC, DCXO
  - Dual-mode NB-IoT & GNSS RF transceiver supports GPS, Beidou, and Galileo constellations

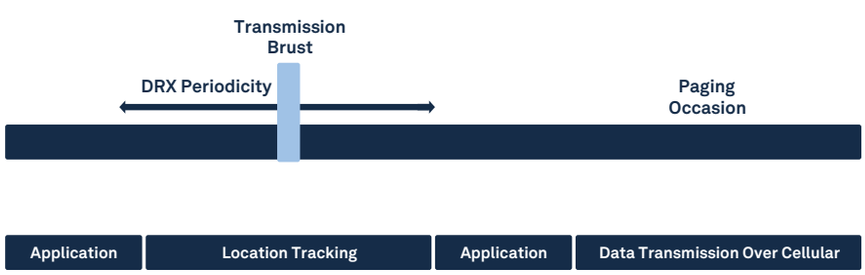
NB-IoT Single Chip Architecture



Multi-mode IoT Use Cases with eNB-IoT connectivity

- Asset or person tracking (children, elderly, dogs, cars, bikes, logistics)
- Geo-fencing when asset/person leaves a pre-defined virtual area
- Identification of fixed devices (smart meters, light and parking city sensors)
- Smart home hub between home meshed connectivity, (BLE, Zigbee/Thread) and NB-IoT backahul
- Sensor fusion for untethered activity trackers and wearables
- ClearVox, voice front-end software for Building, Home security, elderly and eHealth with always-on voice trigger, Voice commands and Sound sensing

Multi-mode Asset Tracker Ceva-X1 timing diagram



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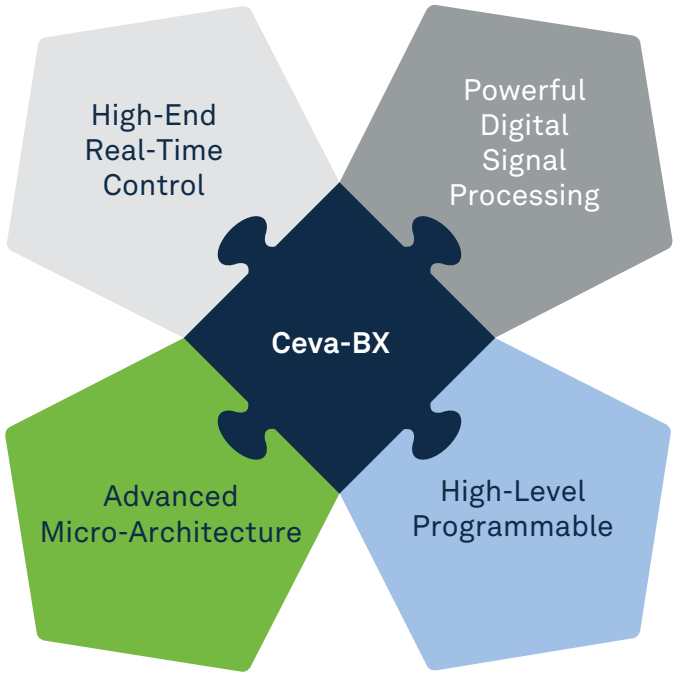
For more information:

High level programmable, modern processor architecture for a broad range of signal processing and control workloads

Ceva-BX1 is a multipurpose hybrid DSP and Controller designed for the inherent low power requirements of DSP kernels with high-level programming and compact code size requirements of a large control code base.



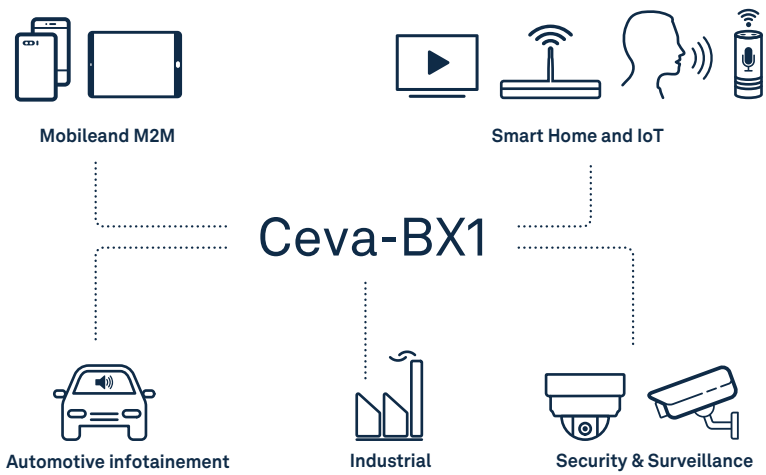
Key Benefits

- **Perfect alternative** for special purpose DSPs and MCUs with DSP co-processors,allowing efficient handling of today's diverse algorithm needs
- **Fast software bring up** using a comprehensive tool chain and DSP libraries
- **Advanced Neural Network** support for deep learning at the edge
- **Compact code size** and **low power** using inbuilt mechanisms

Tools and Software Availability

- **Application specific ISA and software:**
  - **ClearVox** - multi-mic noise reduction
  - **WhisPro** - speech recognition
  - **Cellular** IoT and **GNSS** ISA
- DSP and neural network compute libraries
- Common neural network frameworks support
- Advanced LLVM compiler
- Eclipse based debugger
- RTOS

Target Markets



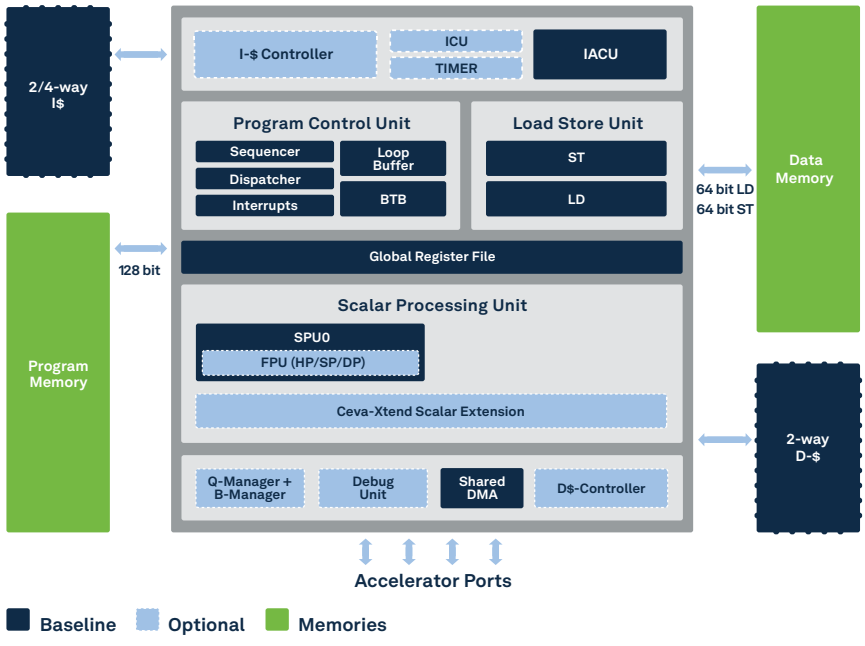
Multipurpose DSP/Controller

The CEVA-BX1 architecture delivers excellent all-round performance for a new generation of smart devices by offering a high performance hybrid architecture that is a single compute island for all DSP andcontrol workloads.

Ceva-BX™1

Architecture Highlights

- **Powerful DSP performance**
  - 4-way VLIW
  - 8/16/32/64-bit data types
  - Dual 32x32 MAC
  - Quad 16x16 MAC
  - 16x8 and 8x8 Neural Network support
  - Half, single and double precision IEEE floating point units
- **High performance controller**
  - 3.73 CoreMark/MHz
  - Dynamic branch prediction
  - Full RTOS support
  - Secured execution modes
  - Compact code size
- **Advanced System Control**
  - Automatic buffer management
  - High QoS with queue managers
  - Dedicated HW accelerator ports
  - Advanced multi-way instruction and data cache subsystem



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