



Intel® Integrated Performance Primitives (Intel® IPP) 6.1

In-Depth

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Intel® Integrated Performance Primitives (Intel® IPP) 6.1

Intel® Integrated Performance Primitives (Intel® IPP) is an extensive library of multicore-ready, highly optimized software functions for multimedia, data processing and communications applications.

Intel IPP is one of the Intel® Performance Libraries, which provide optimized software building blocks to complement Intel’s optimizing compilers and performance optimization tools. For a more complete and cost-effective solution Intel IPP is available as a component of Intel® Parallel Studio, Intel® Compiler Professional Editions and Intel® Compiler Suite Editions or as a standalone product.

Version 6.1 Available Now! Intel IPP 6.1 delivers expanded functionality in data compression and image processing and tighter integration with the Visual Studio* environment. For early software development, IPP 6.1 also includes select optimized functions for the AVX 256-bit instruction set extension to SSE that will be introduced in an upcoming Intel® processor. For more details, please refer to the New Release information below.

Microsoft Visual Studio* Developers: Create Windows* applications more rapidly from within Microsoft Visual Studio 2003*, 2005*, and 2008*, with this versatile library of key algorithmic building blocks for multimedia processing, data compression, encryption, and more.

Features

Multicore Processor Support

Intel IPP 6.1 fully supports today’s multicore computing platforms:

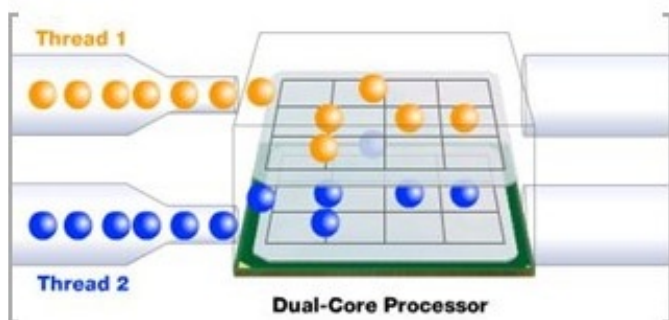


Figure 1. Multicore Processors Enable the True Parallel Execution of Multithreaded Software Applications

- **Multicore-optimized, Threaded Functions:** Over 1,700 critical functions for Matrix and Vector mathematics, Signal/Image Filtering and Convolutions, Image/JPEG Compression, Color Conversion, and Computer Vision are internally threaded to automatically maximize performance on multicore systems.

- **Multicore-optimized Code Samples:** Many of the Intel IPP code samples are threaded to illustrate the effective use of Intel IPP functions in applications such as video encoding and decoding.
- **Fully Thread-safe Functions:** All Intel IPP functions are fully thread-safe, simplifying integration into threaded applications.

Performance-Optimized Functions

Intel IPP functions are designed to deliver performance beyond what optimized compilers alone can deliver by matching the function algorithms to low-level optimizations based on the processor’s available features such as Streaming SIMD Extensions (SSE, SSE2, SSE3, SSSE3, SSE4, SSE4.1, and SSE4.2) and other optimized instruction sets.

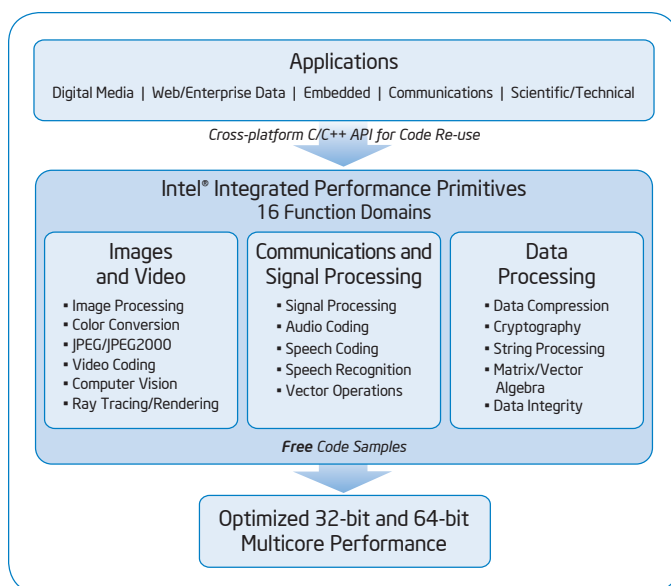


Figure 2. Intel® Integrated Performance Primitives (Intel® IPP) Function Domains and Applications Served

Video Coding:

Key algorithmic components for DV25/50/100, MPEG-2, MPEG-4, H.263, and MPEG-4 Part 10 (H.264) codecs. Figure 2 shows where Intel IPP video coding components (represented by the blue boxes) fit into the H.264 codec process flow. Functions include:

- Motion Compensation
- Motion Estimation
- Modified Discrete Cosine Transforms
- Quantization and Inverse Quantization
- Entropy Coding

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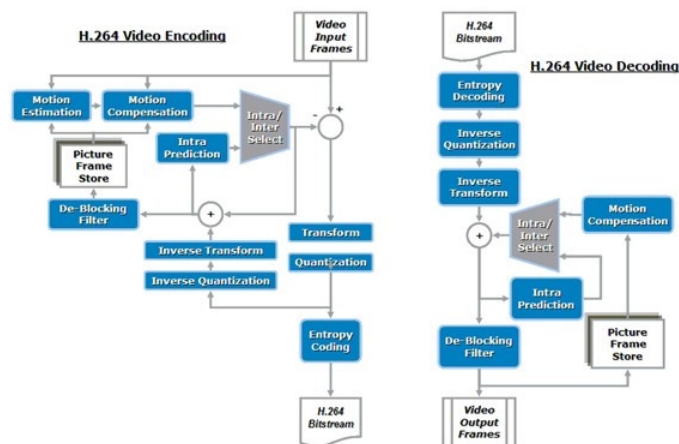


Figure 3. Intel Integrated Performance Primitives (Intel IPP) Components in the H.264 Codec Process Flow

The Video and Audio code samples illustrate sample codec implementations using Intel IPP functions.

Image and 2-D Signal Processing:

Intel IPP is the premier library of image and 2-D signal processing algorithms, and includes a rich selection of algorithms operating on images and regions of interest (ROIs) within images:

Transforms:	Wavelet Fourier (FFT/DFT, real/complex) Windowing (Hamming, Bartlett) Discrete Cosine (DCT)
Filtering Functions:	General linear filtering Convolution/Deconvolution (LR and FFT) Box, Min, Max, Median Wiener Filters Fixed Filters (Prewitt, Sobel, Laplace, Gauss, Scharr, Roberts) Sharpening/Hi-pass/Lowpass Filters
Geometric Transforms:	Resize, Mirror, Rotate, Shear Affine transforms Perspective transformations Bilinear warping Coordinate remapping Super sampling
Image Statistics:	Sum, Integral, Tilted Integral Mean, Min, Max, Histogram, StDev Image Moments Image Norms (L1, L2, infinity) Image Quality Index calculation Proximity Measures (Cross-correlations, Square Distance) Threshold/Compare Operations
Image Arithmetic/Logic Operations:	Alpha composition Arithmetic operations (add/sub/mul/div/sqrt/sqr/ln/exp/abs) Logical operations (AND, OR, XOR, Shift, NOT)
Image Data Exchange/Initialization:	Copy/Set/Transpose Channel swapping Jaehne/Ramp/Zigzag initialization Memory allocation for multiple image types

Computer Vision:

Intel IPP includes optimized functions for many key computer-vision operations, for applications in security, machine control, media management, media annotation, and more:

- Feature Detection (Corner, Canny Edge Detection)
- Distance Transforms
- Image Gradients
- Flood Filling
- Motion Templates Generation
- Optical Flow Calculation (Lucas-Kanade)
- Pattern Recognition (Haar classifiers)
- Pyramid Functions (Gaussian/Laplacian pyramids)
- Universal Pyramid Functions
- Camera Calibration
- 3-D Reconstruction

Intel IPP-based optimization is automatically included in the popular OpenCV open-source computer-vision library, for enhanced performance on real-time tasks, and Intel IPP was a key software component in the winner of the 2005 DARPA Grand Challenge.

Color Conversion:

Today's explosion of digital media in multiple formats brings the need to convert digital media among different color representations. Intel IPP provides a rich set of optimized color-conversion routines on 32/24/16-bit-per-pixel formats:

- Color Model Conversion:
RGB, YUV, YCbCr, BGR, CbYCr, HSV, LUV, Lab, YCC, HLS, SBGR, YCoCg, YCCK, XYZ, CMYK
- Color Format Conversions:
YCbCr422, YCbCr420, YCbCr411, CbYCr422, BGR565, BGR555, BGR565Dither
- Lookup Table Conversions (Linear/Cubic/Palette)
- Color to Greyscale Conversions (Fixed/Custom coefficients)
- Image Bit Resolution Reductions
- Color Twist Conversions (integer/float pixel values)
- Gamma Corrections (Forward/Backward)

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String Processing:

Build optimized text database management, search and retrieval, or document indexing processing into your applications using Intel IPP's optimized string operations.

- Substring substitution/insertion
- String concatenation/splitting
- Upper/lower case conversions
- String/Substring matching
- Regular Expression matching
- Hash value calculation

JPEG Coding:

Key algorithmic components for JPEG, JPEG 2000, and Motion JPEG codecs. Figure 3 shows where Intel IPP JPEG coding components (represented by the blue boxes) fit into the JPEG and JPEG 2000 codec process flow.

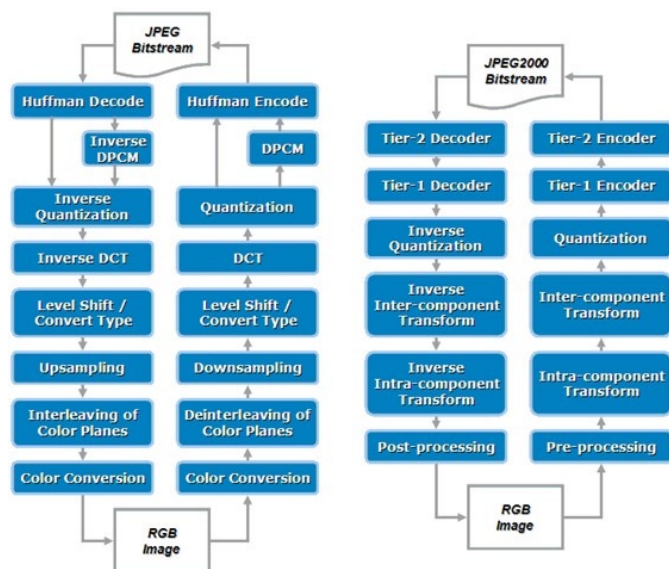


Figure 4. Intel Integrated Performance Primitives (Intel IPP) Components in the JPEG and JPEG 2000 Codec Process Flow

Speech Coding:

Intel IPP includes a comprehensive set of routines supporting the following speech codecs/functions:

- G.722.1
- G.722 Sub-Band ADPCM
- G.723.1
- G.726
- G.728

- Echo Cancellation
- G.729
- GSM-AMR
- AMR-Wideband
- GSM Full Rate
- Companding

Signal Processing:

Includes signal processing features for the following:

Filtering and Convolution:	Finite Impulse Response (FIR) Infinite Impulse Response (IIR) Median filtering Cyclic convolution Auto/Cross-correlation
Transforms:	Fourier (FFT, DFT, Goertzel) Discrete Cosine Transforms (DCT) Hilbert Transforms Wavelet Transforms (fixed/custom filters) Power spectrum calculation
Windowing/Sampling:	Upsampling/downsampling Windowing (Bartlett/Blackman/Hanning/Hann/Kaiser)
Array/Signal Initialization/Manipulation:	Move/copy/set/zero Tone/Triangle/Ramp/Jaehne Generation Random vector generation (Uniform/Gaussian) Array allocation Real/Complex conversion Polar/Cartesian conversion
Array/Signal Statistics:	Sum/Max/Min/Mean/StdDev/Norm Dot products Thresholding Viterbi decoding
Array Arithmetic/Logic Operations:	Arithmetic operations (add/sub/mul/div/sqrt/sqr/ln/exp/abs) Logical operations (AND, OR, XOR, Shift, NOT) Array sorting Magnitude/Phase

Data Compression:

In addition to video, audio and image compression with codecs, Intel IPP provides functions for lossless compression methods, such as those used in the popular "zlib" (inflate and deflate) and "libbzp2" libraries.

Burrows-Wheeler-Transform techniques:	Burrows-Wheeler Transform (BWT) Generalized Interval Transform Move-to-Front (MTF) Run-length encoding (RLE)
Entropy Coding:	Huffman Coding Variable-Length Coding (VLC)
Dictionary-based Compression:	LZSS encode/decode LZ77 encode/decode

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Audio Coding:

Key algorithmic components for MP3, and AAC codecs. Figure 4 shows where Intel IPP JPEG coding components (represented by the blue boxes) fit into the AAC codec process flow. Functions include:

- Huffman Coding
- Spectral Data Pre-Quantization
- Modified Discrete Cosine Transforms
- Block Filtering
- Frequency Domain Prediction
- Spectral Band Replication
- Fast Fourier Transforms

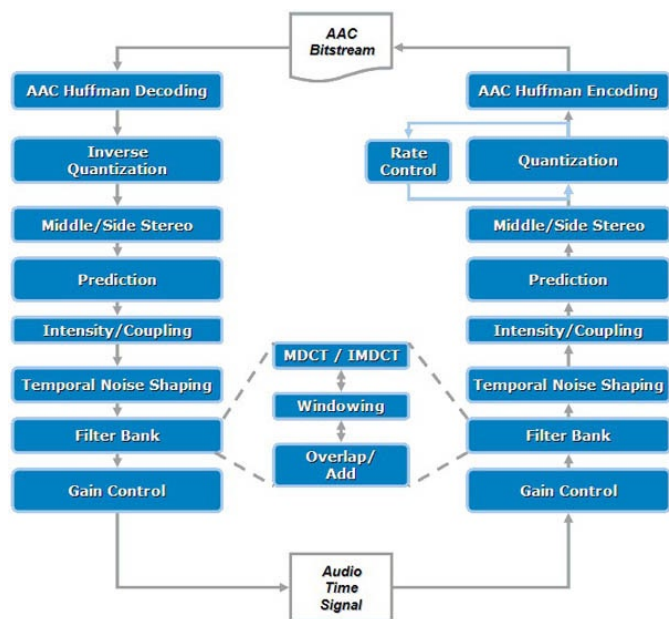


Figure 5. Intel Integrated Performance Primitives (Intel IPP) Components in the AAC Codec Process Flow

Speech Recognition:

Build advanced speech recognition, Voice-over IP, and voice annotation capabilities in applications using Intel IPP's broad range of speech-recognition capabilities:

- Feature Processing
- Model Evaluation
- Model Estimation
- Model Adaptation
- Vector Quantization
- Acoustic Echo Cancellation (AEC)

- Polyphase Resampling
- Advanced Aurora Functions
- Ephraim-Malah Noise Suppression
- Voice Activity Detection

Vector/Matrix Operations

Intel IPP contains a rich set of matrix and vector operations for a wide variety of applications, including physics modeling and 3-D transform/lighting calculations.

Matrix Algebra:	Eigenvalue/eigenvector calculation Least Squares (QR decompositions/back-sub) Linear Systems (LU/Cholesky) Region-of-Interest (ROI) extraction Fast copy of vectors/matrices
Vector Algebra:	Dot products L2 norm calculation "saxpy" (ax + y) operations Linear combination (ax + by) Power/root functions Exponential/Logarithmic/Erf/Erfc functions Trigonometric/Hyperbolic functions Polar/Cartesian conversion

For applications requiring high-performance linear algebra operations on very large data sets, the Intel® Math Kernel Library may also be of interest.

Cryptography:

Use Intel IPP to quickly build robust, high-performance cryptographic modules and applications. Below are some of the many cryptographic building blocks included in Intel IPP's cryptography functions.

Symmetric Ciphers:	Block Ciphers (AES/Rijndael, DES, Triple DES, Blowfish, Twofish) Stream Ciphers (ARC4)
One-way Hashing:	Generalized Hashing (MD5, SHA1-512) Mask Generation (MD5, SHA1-512)
Data Authentication:	Keyed Hash (HMAC-MD5, HMAC-SHA1-512) Data Authentication Functions (DES, TDES, Rijndael, Blowfish, Twofish)
Asymmetric Cryptography:	Elliptic curve cryptography (GF(p) and GF(2m)) RSA algorithm (RSA-OAEP, RSA-SSA) Discrete-Logarithm Cryptography Big-Number arithmetic Montgomery reduction Pseudo-random number generation Prime number generation

Intel IPP's cryptographic functions have been validated according to the Cryptographic Algorithm Validation Program (CAVP).

Name	Standards Certification
Discrete Logarithm (Digital Signature Standard)	FIPS 186-2/Cert 190
Integer Factoring (Digital Signature Standard)	FIPS 186-2, ANSI X9.31-1998/Cert 181
Elliptic Curve Digital Signature Algorithm (ECDSA)	FIPS 186-2, ANSI X9.62-1998/Cert 40
Random Number Generator	FIPS 186-2/Cert 245

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Ray-Tracing and Rendering:

Core operations used in ray-tracing, realistic image rendering, and physics applications:

- Bounding-box calculations
- Object-ray intersections
- Shadow/Reflection calculations

Data Integrity:

Error correcting codes are vitally important to preserving the integrity of data in transmission, storage and encoding. For example, transmission lines can be unreliable and introduce data errors, spurious signals can occur when saving data to a compact disk, and errors can occur when reading bar codes. Using error-correcting codes like Reed-Solomon is a good way to correct these errors.

- Error-Correcting Codes
- Reed-Solomon

New in the 6.1 Release

- Initial support (65 functions) for the Intel® Advanced Vector Extensions (Intel® AVX) 256-bit instruction set extension to SSE that will be introduced in an upcoming Intel® processor
- Major enhancements to the Deferred Mode Image Processing framework including improved multicore performance scaling, extended node types, and thread-affinity API
- Visual Studio Intellisense integration for function name and parameter autocompletion
- `ipp_zlib` and `ipp_gzip` redesigned for improved performance and better zlib integration
- PNG lossless image format now supported under Unified Image Codec (UIC) framework
- DXT1, DXT3, and DXT5 texture compression support
- Photo core transform functions to support High Definition Photo (HD Photo) codec development
- Cryptography functions supporting RSA_SSA1.5 and RSA_PKCS1.5 algorithms
- Spherical harmonic transform function for advanced lighting
- Improved noise detection signal processing function
- Super sampling 3-D geometric transform for image size reduction
- IPP documentation now available in Help 2 format for Visual Studio integration and CHM for improved searchability

New in the 6.0 Release

- Expanded optimizations for the latest Intel® microarchitectures
- Intel® Core™ i7 processor support
 - Intel® Atom™ Processor support
- High-level data compression library support for LZO high-speed algorithm and improved performance for zlib, gzip and bzip2 algorithms
- Preliminary release of the Deferred Mode Image Processing (DMIP) framework, introduced as a sample on top of Intel IPP libraries, provides solutions for pipelined image operations on larger images, utilizes in memory optimization and improves performance in multithreading environment
- Unified Image Codec (UIC) framework to standardize plug-and-play interfaces for various image codecs (JPEG, JPEG2000, etc.)
- Threaded Static Libraries are added to cover all functional domains
- Data Integrity functional domain: Reed-Solomon error correcting codes to preserve integrity of data in transmission, storage and encoding
- New functions in existing domains
 - Signal Processing: Walsh-Hadamard and Discrete Hartley transforms plus higher performance complex and real discrete Fourier transforms (DFT) for various input sizes and input/output formats. (`ippGen`)
 - Image processing: `ippiCopy` and `ippiTranspose` functions
 - Image processing: 3-D transforms—resizing, affine transform and remapping
 - Video coding enhancement: denoising, deinterlasing, demosaicing
- New features and enhancement in Intel IPP samples
 - Microsoft* RT audio support
 - Speech coding standard G729.1 codec support
 - AVS codec support for video decoding
 - Image search descriptors (MPEG7), color layout, edge histogram
 - Super resolution technology, optical flow
 - ALS decoder profile support in AAC decoding
- Intel IPP's thousands of functions cover essential, fundamental algorithms in the following domains:
 - Video Decode/Encode
 - Audio Decode/Encode
 - JPEG/JPEG2000
 - Data Compression

Intel® Integrated Performance Primitives (Intel® IPP) 6.0

- Cryptography – CAVP Validated!
- Speech Coding
- Speech Recognition
- Image Processing
- Image Color Conversion
- Computer Vision
- Signal Processing
- Vector/Matrix Mathematics
- String Processing
- Data Integrity
- Ray Tracing/Rendering

Intel IPP is validated for use with multiple generations of Intel and compatible processors, and is backed by world-class support through the Intel® Premier Support program, and by developer community forums.

Technical Support

Every purchase of an Intel® Software Development Product includes a year of support services, which provides access to Intel Premier Support and all product updates during that time. Intel Premier Support gives you online access to technical notes, application notes, and documentation. Install the product, and then register to get support and product update information.

