Video Conferencing And Telepresence In HD
Imagine a world in which you communicate with peers, colleagues, friends or family, in which you interact with your lecturers, in which you are assisted by a service person at a ticket sales kiosk, and in which surgeons are aided by peers hundreds of miles away … all this through life-like video with full 1920x1080 or 1280x720 resolution. It is not difficult to imagine how this fundamentally changes and enhances our daily lives.

We Don’t Make It, But We Help Make It Better
W&W Communications does not make the video conferencing or telepresence systems, but we make the video codecs that make it possible for these systems to:

- Handle video at 1920x1080 and 1280x720 resolutions,
- Utilize available bandwidth efficiently,
- Perform at near theoretical quality versus bit rate, and
- Virtually eliminate any noticeable delay associated with video encoders and decoders.

The encoder efficiency results in bit rates low enough to allow video at 720p and 1080p resolutions to be carried over broadband connections for real-time communications.

Single Chip HD Encoder
The WW10000BA is a single chip implementation of an H.264/MPEG-4 AVC (Part 10) Baseline Profile HD encoder for video conferencing and telepresence applications.

Key Features
- 1080p and 720p HD resolutions
- H.264 Baseline Profile
- Single chip encoder and decoder
- Low encode-decode tandem delay
- 4 Video input ports
- 4 Video output ports
- MCTF adaptive noise filtering
- Error resiliency and concealment
- CBR control
- MTU fragmentation control
- Flexible encoder tool configuration
- DDR2 memory support
- NAL formatting
- Generic host bus interface
- Software upgradeable
The WW10000BA consists of an H.264 Baseline Profile encoder and supporting I/O blocks. A debug video port is available, which outputs the video from the encode reconstruction path. The pre-processor block performs motion-compensated temporal filtering to remove camera noise. The post-processor performs conversion from progressive to interlaced video formats. The 4 video input ports accept ITU-R BT 709-4, YUV 4:2:2 formatted digital video bit streams for HD resolution video and ITU-R BT 601, YUV 4:2:2 formatted digital video bit streams for SD or lower resolutions. A generic host bus interface provides access to an external host processor for configuration and control of the WW10000BA and for running UDP/RTP network protocol stacks.

Single Chip HD Decoder

The WW10001BA is a single chip implementation of an H.264/MPEG-4 AVC (Part 10) Baseline Profile HD decoder for video conferencing and telepresence applications.

Specifically Optimized

The WW10000BA and WW10001BA encoder and decoder are specifically optimized for video conferencing and telepresence applications. These specific optimizations include:

- Low bit rates at very high quality
- Camera noise filtering
- Low encode-decode tandem delay
- Error resiliency and concealment
- Bit rate optimization
- Packet optimization
- Network abstraction

These optimizations address the key success factors for any HD video conferencing or telepresence system.

Low Bit Rates At Very High Quality

The WW10000BA encoder achieves near-perfect quality versus bit rate when measured against the JVT Joint Model (JM) H.264 reference encoder.

Near-perfect performance versus the JVT Joint Model

It implements a complete set of Baseline Profile encoder tools, including 1/2 and 1/4 pixel interpolation and all luma, chroma and inter-frame coding modes. Skip mode support further reduces bit rates without impacting picture quality by not having to transmit static image sections.

Incumbent MPEG-4 and H.263 encoders are no match for the WW10000BA encoder. It outperforms MPEG-4 and H.263 encoders in terms of lower bit rates at the same PSNR, while handling HD video resolutions.

With bit rates as low as 900Kbps and PSNR more than 38dB for a video conferencing session in 1280x720 resolution at 30 frames/sec, the WW10000BA encoder provides exceptional picture quality at very low bit rates.

Camera Noise Filtering

The WW10000BA encoder implements a content-adaptive, motion-compensated, temporal filter (CA-MCTF). The filter uses proprietary algorithms to constantly adapt filter strength based on content, in order to maintain sharpness and clarity. Filtering happens in a single pass to meet low encode-decode tandem delay requirements. The filter provides significant gains in PSNR, while reducing bit rates significantly further.

Low Encode-Decode Tandem Delay

Optimizations in the encoder and the decoder minimize encode-decode tandem delay. These optimizations result in less than 35ms of tandem delay, or about one frame delay at 30 frames/sec. The extra processing and overhead due to other operations, such as noise filtering, interlacing, bit rate control, NAL formatting and parsing, etc., does not impact this delay. This low-delay property makes it possible to maintain proper lip synchronization in the decoded bit stream and it allows enough margins for transmission-channel delay. These are very important aspects of a practical video conferencing or telepresence system.
Multi-stream Processing
The encoder and decoder are capable of processing multiple streams of video over each of their four video input and output ports. This makes it possible to have multiple camera angles, for instance one for participants and one for presentations, or dedicate one camera per participant. Another possibility is to have multiple angles for presentations and one for participants, for instance in a telemedicine application, where multiple camera angles are used to provide feedback on a surgical procedure. Flexibility in frame rate per stream conserves transmission bandwidth, where a given frame rate budget is dynamically allocated between speakers and listeners.

The total frame processing capacity is 600 CIF frames/sec. This total capacity can be split in streams of different resolutions and frame rates. Using CIF as the basic unit for resolution, a D1 frame equates to 4 CIF frames, a 720p frame equates to 8 CIF frames and a 1080p frame equates to 20 CIF frames. The table below provides several examples of splitting up the total frame processing capacity into streams of different resolutions and frame rates. Presently only one stream per input port is supported on the encoder.

<table>
<thead>
<tr>
<th>Res.</th>
<th>CIF</th>
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<th>1080p</th>
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<td>15Fps</td>
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<td>6x4</td>
<td>12x1</td>
<td>30x2</td>
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</table>

Flexible distribution of total frame processing capacity over video streams

The WW10000BA and WW10001BA use proprietary, highly parallel architectures to achieve such high frame processing rates and flexibility in stream processing. These encode and decode architectures allow operation at much lower clock frequencies than otherwise possible and consequently also at much lower power dissipation.

Error Resiliency And Concealment
The WW10000BA encoder implements several error resiliency features. These include I-frame forcing, Intra-refresh, variable GOP size (1 through infinity) and variable slice size. Intra-frame forcing produces a new I-frame at once, while Intra-refresh does this one slice at a time, optimizing for limited channel bandwidth. Similarly, variable GOP size and variable slice size optimize available bandwidth.

When the WW10001BA decoder encounters bit errors or packet loss in the received bit stream, it uses the H.241 protocol to raise a flag for the external host processor to request an Intra-frame or Intra-refresh from the encoder. When an error is encountered, the decoder freezes the video at the last good frame. Recovery happens quickly within a few frames.

Bit Rate Control
The WW10000BA implements CBR (Constant Bit Rate) control to prevent transmission channel capacity overflow and uses proprietary algorithms to ensure quality versus quantization strength. To meet low encode-decode tandem delay requirements, single-pass algorithms are used, which nonetheless do not affect the video quality.

Packet Optimization
In order to take full advantage of the capacity of the network, the WW10000BA encoder stuffs packet payloads up to the maximum transmission unit (MTU) size specified by the particular network protocol that is targeted (such as RTP for instance). Proprietary algorithms are used to achieve payload optimization in a single pass to meet low encode-decode tandem delay requirements.

Network Abstraction
The encoder formats its output bit stream in NAL (Network Abstraction Layer) units for transmission over a network. The decoder parses the NAL units for decoding of the payload. NAL formatting specifies a generic format for packet-oriented and bit-stream applications.

Flexibility
The WW10000BA and WW10001BA provide a great deal of flexibility in configuration. On the encoder various parameters can be set independently for each video stream, such as bit rate, GOP size, search area size, error resiliency, CA-MCTF filtering, etc. On the decoder various parameters can be set independently as well for each video stream. For instance, error concealment, video output stream and video output port binding, etc.

Ease Of Design
A generic host or optional PCI bus interface, combined with support for mainstream DDR2 memory and industry standard video interfaces makes designing with the WW10000BA and WW10001BA very easy. In addition, availability of drivers and utilities, further eases system design greatly. Finally, a comprehensive development kit is available that speeds up hardware and software design.
Features

**Video Compression**
- H.264 Baseline Profile
- Large search area (384x256 pixels)
- Single-pass, multiple block motion estimation
- Half and quarter pixel interpolation
- All Intra-4x4 luma modes
- All Intra-16x16 luma and chroma modes
- All Inter modes and SKIP mode
- In-loop de-blocking filter
- CAVLC entropy encoding

**Rate Control**
- Constant bit rate, up to 50Mbps

**Delay and Latency**
- Less than 35ms or single frame encode-decode tandem delay
- ~2ms encoder and decoder latency

**Network Support**
- Encoder NAL bit stream formatting
- Decoder NAL bit stream parsing

**Video Inputs and Outputs**
- 4x Encoder video input ports
- 4x Decoder video output ports
- 1x Encoder video output debug port

**Error Resiliency & Concealment**
- Intra-frame forcing
- Intra-refresh
- Variable GOP size
- Variable slice size
- H.241 signaling protocol

**Noise Reduction**
- CA-MCTF

**Resolutions**
- 1920x1080, 50/60 fields/sec, or 30 frames/sec
- 1280x720, 30 or 60 frames/sec
- D1, CIF, QCIF, VGA, QVGA
- Custom resolutions

**Operational Characteristics**
- Power dissipation ~8W
- 110MHz clock frequency
- 0°C – 60°C ambient temperature
- 0-90% RH

**Package**
- 1,020 pin FineLine BGA
- 33mm x 33mm

**Operational Characteristics**
- Power dissipation ~8W
- 110MHz clock frequency
- 0°C – 60°C ambient temperature
- 0-90% RH

**Configuration Support**
- Configuration per stream
- Frame rate
- Resolution
- Bit rate
- Quantization
- GOP size
- Number of slices
- Search area
- MCTF on/off
- Error resiliency
- Statistics

**Miscellaneous Interfaces**
- JTAG
- GPIO
- Thermal diode output

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW10000BA</td>
<td>Multi-channel low-delay H.264 BP HD video conferencing encoder</td>
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<tr>
<td>WW10001BA</td>
<td>Multi-channel low-delay H.264 BP HD video conferencing decoder</td>
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